

# CHEMICAL AND BIOLOGICAL WARFARE

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HEARING  
BEFORE THE  
COMMITTEE ON FOREIGN RELATIONS  
UNITED STATES SENATE  
NINETY-FIRST CONGRESS  
FIRST SESSION

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APRIL 30, 1969

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# CHEMICAL AND BIOLOGICAL WARFARE

WEDNESDAY, APRIL 30, 1969

UNITED STATES SENATE,  
COMMITTEE ON FOREIGN RELATIONS,  
*Washington, D.C.*

The committee met, pursuant to notice, at 10:05 a.m., in room S-116, the Capitol Building, Senator J. W. Fulbright (chairman), presiding. Present: Senators Fulbright, Mansfield, Gore, Symington, Dodd, McGee, Aiken, and Case.

Also present: Representative McCarthy of New York.

The CHAIRMAN. The committee will come to order.

The Committee on Foreign Relations is meeting today in executive session to be educated by Dr. Matthew S. Meselson on the subject of chemical and biological warfare.

## REASONS FOR COMMITTEE'S INTEREST

The committee's interest stems from several recent developments: The submission by the United Kingdom of a working paper on microbiological warfare weapons to the 18-nation Disarmament Committee, and the formation earlier this year of a United Nations Special Committee, on which the United States is represented, to examine and report on the characteristics and security implications of chemical and biological weapons.

In recent statements, both President Nixon and Premier Kosygin have expressed their interest in discussing the control of chemical and biological weapons at Geneva. As chemical and biological weapons may soon be the subject of serious international negotiations, the matter is thus clearly within this committee's responsibility. There are, of course, wider aspects of this problem that follow from the question of whether or not to adhere to a treaty and what part to play in the United Nations Special Committee.

Just as in the case of nuclear weapons, biological and chemical weapons have the capability literally of destroying the human race. Yet we know so little about these weapons, and about what we are doing and what other nations are doing in developing and stockpiling them even though they could destroy us. As Dr. Meselson himself pointed out recently in *Science* magazine, these matters have received almost no careful public or congressional scrutiny.

Our witness today has long had a special interest in the disarmament aspects of chemical and biological weapons. Currently a professor of biology at Harvard, he has served as a consultant to the Arms

NOTE.—Sections of this hearing have been deleted in the interests of national security. Deleted material is indicated by the notation "[Deleted]."

Control and Disarmament Agency. I wish to insert at this point in the record a more complete biography of Dr. Meselson.  
(A biographical sketch follows:)

**MATTHEW S. MESELSON, PROFESSOR OF BIOLOGY, HARVARD UNIVERSITY**

Born: May 24, 1930, Denver, Colorado.

Address: Biological Laboratories, Harvard University, Cambridge, Massachusetts 02138.

Academic background: Ph.B., Liberal Arts, University of Chicago, 1951; Ph.D., Physical Chemistry, California Institute of Technology, 1957; Research Fellow, California Institute of Technology, 1957-58; Assistant Professor of Physical Chemistry, California Institute of Technology, 1958-59; Senior Research Fellow in Chemical Biology, California Institute of Technology, 1959-60; Associate Professor of Biology, Harvard University, 1960-1964. Fellow, American Academy of Arts and Sciences; Member, U.S. National Academy of Science.

Government affiliation: Consultant, Arms Control and Disarmament Agency since 1963.

Recipient: National Academy of Science Prize for Molecular Biology, 1963; Eli Lilly Award in Microbiology and Immunology, 1964.

The CHAIRMAN. Dr. Meselson, we appreciate very much your taking the time and trouble to come here to consult with us and to give us the benefit of your knowledge in this field.

I want to confess at the outset that I know so little about the subject, that my questions may seem very naive indeed. We have with us today Congressman McCarthy who has given a good deal more study to this than I have, and we welcome his interest. You may proceed.

It does interest me that you are a biologist primarily; is that right?

**STATEMENT OF MATTHEW S. MESELSON, PROFESSOR OF BIOLOGY,  
HARVARD UNIVERSITY**

Dr. MESELSON. Yes, sir; that is right.

The CHAIRMAN. Isn't Dr. Wald a biologist also?

Dr. MESELSON. Yes, George Wald is.

The CHAIRMAN. He seems to be very conscious, from what he says, of what the adult generation is doing to the world we are in. Recently I saw a very interesting article, relating to a hearing in the House, which quoted a Mr. Kominor on what we are doing technologically to our environment. I imagine this is also something you are interested in.

Will you proceed, Dr. Meselson?

Dr. MESELSON. Thank you, Senator.

Would you prefer that I read all or part of my prepared statement?

The CHAIRMAN. I have not had a chance to read it. I think we will let you be the judge. If it is too long to read, we could put it all in the record and you could emphasize what you believe should be called to our attention. You are the best judge of that.

Dr. MESELSON. I would like to read page 1.

The CHAIRMAN. All right.

Dr. MESELSON. Page 1 is the table of contents of this statement I have prepared for you this morning. It has an introductory portion which I would like to read.

The CHAIRMAN. All right, read anything you like. We have no other witness this morning, and at least I am going to stay with you. I want to learn something about the subject.

Dr. MESELSON. That part is relatively short. Then it is followed by a definition and description of actual chemical and biological warfare agents, and I hope you will stop me if in reading that, I seem to be going on to no good purpose.

Following that, there are some remarks about chemical weapons policy, and then there are four appendixes which are documents as indicated on page 1 of my statement.

If I might, then, I would like to read——

The CHAIRMAN. You go ahead and read all of it, if you think that is the best way. I, for one, would be interested in it.

#### BACKGROUND OF WITNESS

Dr. MESELSON. My name is Matthew Meselson and I am a professor of biology at Harvard University. I was trained in the field of chemistry at Harvard University, and my present teaching and research activities are in the area of genetics and biochemistry. My concern with the problems posed by chemical and biological weapons stems from the summer of 1963 during most of which I served full time as a consultant to the U.S. Arms Control and Disarmament Agency in Washington.

My assignment was to study arms control possibilities for chemical and biological weapons. In doing that I read both classified and unclassified material. I visited Fort Detrick which, as you know, is one of our chemical and biological warfare research installations.

#### EXPECTED PUBLICATION OF RECORD

The CHAIRMAN. Will the Doctor allow me to interrupt? I should have said for the record, I did say prior to the opening of the hearing, that while this is an executive meeting it is anticipated that, subject to sanitizing by Dr. Meselson, this record may be made public. I would like everybody to be conscious of that possibility, because I think it is the kind of record that the public needs to be informed about. The record is being kept secret today, not for any security reasons that I know of, but simply to help us learn about the subject. So in our questions and answers, let us keep that in mind. Afterward, I would imagine, this record will be made public subject to your changes. If you put something in that is based on classified material, and later you think it should come out, we will take it out, but you should be free now to go ahead and say it.

Dr. MESELSON. Thank you.

The CHAIRMAN. I just want the ground rules to be understood. So proceed.

Dr. MESELSON. Since that summer of 1963 I have continued to serve as a consultant to the Disarmament Agency. However, I would like to emphasize that I appear here today purely as a private citizen, in no way representing any part of the U.S. Government.

#### CHEMICAL AND BIOLOGICAL WEAPONS NEED ANALYSIS

Because of its leading military and political role in the world today, the United States can exert an important and possibly decisive effect on the factors that act to restrain or encourage CB warfare.

This fact argues strongly against basing our policy on a weapon-by-weapon or situation-by-situation analysis and calls instead for the formulation of an overall policy on which decisions regarding particular weapons or particular situations can be based. Stated another way, decisions involving toxic, that is, chemical or biological weapons, are likely to have important effects on the military environment we face years after those decisions are made.

I am concerned that U.S. policy for chemical and biological weapons has not received the farsighted analysis it deserves. In part, I feel this is because our chemical and biological warfare programs and policies have been largely shielded from public and especially congressional scrutiny. In what follows, I would like to present a brief description of certain CB weapons and a general discussion of their implications for national policy.

#### DEFINITION OF CHEMICAL AND BIOLOGICAL WEAPONS

Chemical and biological warfare has been defined by the U.S. Army as follows: Chemical warfare (CW)—Tactics and technique of warfare by use of toxic chemical agents.

Biological warfare (BW)—Employment of living organisms, toxic biological products, and chemical plant growth regulators to produce death or casualties in man, animals, or plants; or defense against such action.

#### STANDARD ANTIPERSONNEL CHEMICAL AGENTS

The United States at present has seven so-called standardized chemical warfare agents. I would like, with your permission, to describe those seven agents, Senator, and I am relying in part on the unclassified Army Field Manual 3-10, dated March 1966. This is the most recent edition of the manual entitled "Employment of Chemical and Biological Agents." I repeat, this manual is unclassified.

Senator DODD. Mr. Chairman. The chairman pointed out, I think wisely, that we could hear even the classified information. I think it would be helpful.

The CHAIRMAN. If you wish to rely on classified information, state so for the record and we will take it out later.

Dr. MESELSON. I will, Senator.

The CHAIRMAN. That is fine.

#### NERVE AGENT—GB

Dr. MESELSON. The first agent that I would like to describe is the lethal agent called GB. This was developed in Germany during World War II. The German name for it is Sarin. It is a nerve gas.

GB is one of the highly lethal nerve gases developed but not used by Germany during World War II. It is a quick-acting lethal agent intended to enter the body by inhalation. Protection can be afforded by a gas mask. GB can be made available in a wide variety of munitions and delivery systems including landmines, mortars, artillery shells, rockets, and bombs. It can also be dispensed from aircraft by means of special spray tanks. The performance of poison gas weapons, such as those containing GB, is highly dependent upon

meteorological conditions. However, for rough descriptive purposes, it may be said that the explosion of an artillery shell containing 6 pounds of GB will kill most unmasked personnel within an area approximately the size of two football fields around the site of the burst.

At the other end of the magnitude scale, an attack on an urban area by a bomber dispensing GB might be able to kill most unmasked persons within an area of at least 5 square miles, this being the size of the zone of high mortality caused by the Hiroshima and Nagasaki atomic bombs. By high mortality, I mean 5 percent or higher. I have used the words "might kill" in the previous sentence in order to indicate that the statement is based on rather simple calculations and not on results of actual field tests on a simulated urban target. The properties and means for production of GB are relatively well documented in the open literature. [Deleted.]

#### CAPACITY OF NERVE GASES

The CHAIRMAN. Has it any other name?

Dr. MESELSON. It has, of course, a chemical name.

The CHAIRMAN. When you say "lethal" you mean it kills—not just immobilizes.

Dr. MESELSON. No, it doesn't just immobilize.

The Chairman. It kills people?

Dr. MESELSON. Somehow the misunderstanding that nerve gases merely incapacitate is rather widespread. I don't know where it comes from, and it is totally false. Nerve gases kill.

Senator DODD. Have you had tests with animals or anything like that?

Dr. MESELSON. Yes; there have been intensive tests with animals.

The CHAIRMAN. And it kills animals?

Dr. MESELSON. It killed 6,000 sheep in Utah.

The CHAIRMAN. Is this what killed them?

Dr. MESELSON. No; it is the next agent.

The CHAIRMAN. But it is similar?

Dr. MESELSON. It is similar. It is one of the family of phosphorous-based nerve gases. GB, as I say, is one of the older ones, developed in Germany.

#### NERVE AGENT—VX

The next one, VX, which was developed by Great Britain in the late fifties, is somewhat different.

The CHAIRMAN. When you use the word "lethal" you mean killing?

Dr. MESELSON. I mean killing.

The CHAIRMAN. That is what I want to understand.

Senator GORE. Is the death instantaneous?

Dr. MESELSON. No; it is not absolutely instantaneous. With GB it is, however, very rapid, within a matter of seconds. It is an important—

Senator DODD. That is pretty rapid.

Dr. MESELSON. It is an important attribute of GB that it kills almost instantaneously because in tactical situations one wants instantaneously to stop the military activities of the enemy.

## SOVIET DEVELOPMENTS IN CB WARFARE

Senator SYMINGTON. Mr. Chairman, if there are some questions being asked, I would just like to ask one question. If the Soviets are developing this type and character of chemical and biological warfare, which I have followed myself, are you recommending we do not develop any?

Dr. MESELSON. I will not recommend any——

The CHAIRMAN. He is not recommending anything. He is giving us a very basic briefing on what we are dealing with. I really called the hearing to inform an ignorant person. He has just started to describe what we are dealing with.

Dr. MESELSON. I might interject that later on I will express the view we should continue certain kinds of research in this area.

The CHAIRMAN. You don't need to anticipate all the——

Senator GORE. It might be well to note here in the record that Mr. Helms has been requested to advise the committee at the appropriate time of Soviet developments in this field.

Senator Dodd. I just want to be sure I am right. As I understand, Dr. Meselson, what you are telling us, is that we can do something to get agreements that will help to curb the use of it; isn't that so?

Dr. MESELSON. I would hope so.

The CHAIRMAN. We draw the conclusions, 'Tom. He is here to tell us what we are dealing with. The main purpose of the meeting is to find out about it, not what to do about it.

Dr. MESELSON. My statement is divided into two parts. The first is an attempt to describe very briefly the standard agents and the second part——

The CHAIRMAN. I suggest we go along and learn what we are talking about. Go ahead.

## STANDARD CHEMICAL AGENT VX

Dr. MESELSON. The second standard chemical agent in the U.S. arsenal is called VX. I will read about VX. This is a lethal agent that enters the body primarily by absorption of liquid droplets through the skin. A gas mask, as well as complete covering of the body, that is a protective suit, is required for protection against VX. The same general types of munitions and delivery systems as listed above for GB may be used for VX [Deleted.] A tiny droplet of VX on the skin will cause death. It appears that VX or an agent closely related to it was responsible for the accidental killing of approximately 6,000 sheep near the Dugway proving ground in Utah last March. The affected sheep were grazing within an area of approximately 200 square miles located at an average distance of approximately 80 miles from a test area where an aircraft had conducted an operation test of a nerve gas spray system. Detailed information concerning VX is classified.

## BLISTER AGENT HD

The third agent I wish to talk about is the blister agent HD or more familiarly mustard gas, the gas so widely used in World War I. It primarily causes incapacitation rather than death. Casualties are

produced by blistering action on the eyes, skin, and respiratory tract. As in the case of nerve agent VX, protection against HD is afforded by a special suit and a gas mask. Weight-for-weight, HD is much less effective than VX in producing casualties. [Deleted.]

#### INCAPACITATING AGENT BZ

The fourth agent I wish to describe is the incapacitating agent BZ. This agent is classed as a temporary incapacitant. It interferes with normal mental and bodily processes. It can cause violent and irrational behavior and its effects may persist for several days. Most information regarding agent BZ is classified. Aircraft delivery systems are available for its dissemination.

#### RIOT CONTROL AGENT CS

The next agent is riot control agent CS. This agent, sometimes called "super tear gas" has been used in large quantities by U.S. forces in South Vietnam. It attacks the eyes, nose, and throat even in extremely low concentrations and also causes nausea. Its effects continue for approximately 10 minutes after exposure to fresh air. It is not generally lethal to healthy personnel even at quite high concentrations. However, a few deaths from CS in Vietnam have been claimed.

I might say here, the claims to which I refer are not official claims but claims by unofficial observers. [Deleted.]

#### RIOT CONTROL AGENT CN

The sixth agent standardized by U.S. forces is the riot control agent CN. This is ordinary tear gas commonly used by police in this country and other countries. It was also used in considerable quantity in World War I and manufactured in large quantity but not actually employed in World War II.

The CHAIRMAN. What does it do? In just one word, what does it do? The same as CS?

Dr. MESELSON. Basically, yes, Senator. It requires more of CN to temporarily incapacitate a man than CS. CS is more powerful in that regard.

The CHAIRMAN. The effect is about the same?

Dr. MESELSON. The effect is about the same. And many of us have probably had a whiff of CN. It is the ordinary tear gas.

The CHAIRMAN. Yes. Go ahead.

#### RIOT CONTROL AGENT DM

Dr. MESELSON. The seventh agent is riot control agent DM. This agent causes violent sneezing, nausea, and vomiting. It may also be lethal under certain conditions, and, therefore, is not approved under current U.S. policy for operations where deaths are not acceptable. It was first produced for military purposes during World War I.

It may have been used in Vietnam in 1965.

Senator DODD. Mr. Chairman, I know what you said and I agree with you, but I notice that he says, I think, with respect to two of these, the information is classified. I think we ought to know what it is.

The CHAIRMAN. You said the specifics are classified, didn't you?

Dr. MESELSON. Oh, yes. There is no classified information in my prepared testimony. If I do describe any classified details I will say that before I make any classified statements.

Senator DODD. I just wanted to know if it was classified.

Dr. MESELSON. I have been careful to avoid putting any classified information in the prepared statement.

The CHAIRMAN. So this statement itself does not contain classified material?

Dr. MESELSON. Not at all.

The CHAIRMAN. So it can be used publicly?

Dr. MESELSON. Completely freely. I prepared it in my home in Cambridge, Mass., which is not authorized for classified documents.

Senator SYMINGTON. Mr. Chairman, so that my observation was not misunderstood, I am very grateful to get this statement. I congratulate you for bringing it up, and I think it is a tremendously important subject.

The CHAIRMAN. Proceed, Doctor.

#### BIOLOGICAL WARFARE AGENTS

Dr. MESELSON. Now, I would like to discuss biological warfare agents.

Specific information on biological agents and weapons systems is classified. Nevertheless, certain general principles regarding the use of biological agents are widely known. Various germs, that is bacteria, rickettsia, fungi, and viruses, have been examined for utility as weapons against humans, animals, and crops.

Now, I have a set of rather short paragraphs describing some general properties of biological agents.

Because of the very small weight of biological agents needed to cover a given area, biological weapons have been considered for use mainly against large areas. I might also interject at this point that unlike chemical agents, biological agents take some time before their effect is manifested, the so-called incubation period before the disease appears. So there is a time of between one and a few days between the time of a biological attack and the time that one would expect symptoms to appear. For that reason, because of that delay, they are not generally considered for tactical use on the battlefield, but rather for strategic use.

#### AEROSOL CLOUD

The most generally considered mode of attack by a biological weapon would be the release of an aerosol cloud, by planes or drones—

Senator CASE. Is that a word or is that a description of something that you buy in a can?

Dr. MESELSON. Aerosol is a word meaning a fine mist.

Senator CASE. I see.

Dr. MESELSON. Released by planes, drones, missiles, offshore submarines, or offshore ships.

For infection of target personnel to occur, particles from the aerosol mist must generally lodge in the deep recesses of the lungs. A well fitting gas mask, or possibly certain simpler protective devices, can

afford a large measure of protection, given adequate advance warning of attack.

For military purposes, it is desirable that epidemic spread of the disease to those outside the immediate target area be avoided. Therefore, only those diseases which can infect the target population but which are believed to be incapable of man-to-man transmission are considered for military use.

Let me explain that. There are some diseases for which we think, although we are not absolutely sure, that infection [deleted] will not spread from one person to another. Such a disease would not start an epidemic but would infect all of the persons directly exposed to the aerosol cloud at the time of attack. That is the distinction I intend here.

Aerosol attack would cause the pulmonary form of a given disease. Generally this is not the most commonly occurring form under natural conditions. The pulmonary form of a disease, that is, the form which strikes first in the lungs, is generally more severe, more rapid in its development and more difficult to treat than other forms. Other forms would be the cutaneous form of the disease where the portal of entry is the skin or the intestinal form where the entry is through the gut. The pulmonary form is relatively rare for most diseases and we know much less about the pulmonary form of diseases than we do about other forms.

#### EFFECTIVENESS OF A BIOLOGICAL AEROSOL ATTACK

The effectiveness of a biological aerosol attack on human populations is extremely difficult to predict. Poorly understood and highly variable factors that determine man's resistance to infection are involved. Additional serious uncertainties can be introduced by meteorological and atmospheric conditions and by complicated factors that influence the survival of infectious organisms in the air.

If biological weapons can be brought close to anything like their potential efficiency, very small amounts would suffice for the attack of large areas. Under such conditions, a single aircraft would be capable of attacking an area of many thousands of square miles.

Field Manual 3-10 presents an illustrative discussion of biological agent employment in terms of three hypothetical antipersonnel biological agents designated as "Lugo fatigue," "September fever," and "Toledo infection." These are hypothetical diseases. [Deleted.]

Senator GORE. When you say "hypothetical" do you really mean hypothetical, or do you mean this is a fictitious title?

[Deleted.]

Dr. MESELSON. I would like to say if our country felt that it did need to reserve the right to use biological agents, then it would make some sense to keep the names of those agents secret because otherwise the enemy could prepare a better defense than if it were ignorant.

Senator DODD. I think our secrets are helpful to the other side and harmful to us.

The CHAIRMAN. I think so, too. Secrecy keeps information from our own people.

[Deleted.]

Senator SYMINGTON. Where is Fort Detrick?

Dr. MESELSON. It is in Maryland.

[Deleted.]

Senator SYMINGTON. Where in Maryland?

Dr. MESELSON. It is near Frederick. The other Chemical Corps facility in Maryland is Edgewood Arsenal.

To go on with my description of biological agents, I was saying that because it is unclassified, Field Manual 3-10 does not refer to actual biological agents. Nevertheless the information given for the three hypothetical agents may be taken as illustrative of the properties to be expected for actual biological agents. Table 5, from that manual, "Hypothetical Anti-Personnel Biological Agents and Delivery Systems," taken from Field Manual 3-10, is presented as appendix I to my statement. (See page 25.)

I might add that in an earlier edition of Field Manual 3-10—namely, in the edition of February 1962—detailed information is given for the carrying out of a biological attack. A series of graphs or monograms is presented there which tell how many biological agent bomb-lets must be dropped by an aircraft to cover a given area under given conditions of daytime or nighttime, type of terrain, et cetera. [Deleted.]

#### BIOLOGICAL WEAPONS REQUIRE SOPHISTICATED EFFORT

Senator SYMINGTON. Doctor, if this is true, after we spend millions, if some country got angry, all they would have to do is take a room and walk out and the next thing you know everybody starts dying; correct?

Dr. MESELSON. Not really.

Senator SYMINGTON. Why not?

Dr. MESELSON. That is a widely held impression. But making a biological weapon which would have a predictable effect requires a sophisticated effort. [Deleted.]

Senator SYMINGTON. You mean Switzerland or Israel wouldn't know how to do it?

Dr. MESELSON. They would not know how to prepare a biological weapon that would have any reliability, in my opinion.

Senator SYMINGTON. Neither Switzerland or Israel?

Dr. MESELSON. I doubt it. Not unless they committed themselves to a large research and testing effort.

Senator SYMINGTON. That is the first optimism heard this week.

#### EXPLOSION OF A BIOLOGICAL WEAPON

The CHAIRMAN. Let me ask you one question in connection with that: Supposing instead of a megaton nuclear bomb in the war-head of a Minuteman, we explode the equivalent weight of anthrax or whatever is most effective, 1 or 2 or 10 miles above a country, let's say Russia, what would be the effect of that?

Dr. MESELSON. The answer, Senator, is that nobody knows today. It might be highly lethal over thousands of square miles. It might kill nobody. We just don't know. I might point out though that even if it were highly lethal, such a weapon would have no effect whatso-

power in reducing the ability of the enemy to shoot missiles back at us because, unlike a hydrogen bomb, anthrax doesn't damage military installations.

Senator SYMINGTON. Yes, but you don't know. You can shoot it high, so you wouldn't know of a burst.

Dr. MESELSON. It might kill a lot of people but [deleted], there is no counterforce capability in a biological weapon. You cannot reduce nuclear damage to your own country.

Senator SYMINGTON. If I follow the Chairman, that would be no real defense whatsoever. In the first place the Spartan was not designed as a defense for a Minuteman base. In the second place a high-altitude explosion would be far higher than the Sprint could go.

The CHAIRMAN. You know about the debate going on about the ABM? It occurred to me that if the Russians are really trying to do what the Secretary of Defense says, which is develop a first strike capability, which means the physical destruction of our country, if that is their purpose, then wouldn't it be just as simple, or maybe simpler, for them to send over enough anthrax, particularly over our populated areas, and explode it? What are the probabilities, if you exploded one over New York City or the eastern seaboard? Would it have an effect, or not?

Dr. MESELSON. To do that would be even more foolhardy than to attack the United States with nuclear weapons for the reason that any biological agent takes a while before casualties begin to appear. Like any disease, you have to catch it, it has to incubate, before the disease comes out. It means whole days would elapse between the time a country knows that something is wrong, and the time that people start dying.

Senator SYMINGTON. So?

Dr. MESELSON. In those days we could fire all the missiles we have at the Soviet Union. In other words, they would not in any way degrade our ability to retaliate against them by using a biological weapon. Biological weapons do not damage missiles. Moreover, even after a BW attack had inflicted its casualties, the survivors could launch a nuclear retaliation.

Senator SYMINGTON. How would you know they had done it?

Dr. MESELSON. Done what, Senator?

Senator SYMINGTON. How would you know who had fired it as more and more nations get the bomb?

Dr. MESELSON. How would anyone know where any missile came from? I don't know the answer to that question.

Senator SYMINGTON. Well, that is a good answer. Nobody would know if you fired one from a submarine 500 miles south of Hawaii. There was a lot of discussion in World War II about destroying crops. In that case it would be an airplane. I would think a missile would be a very simple way. You don't have the gigantic noise, et cetera, plus all the reaction of a nuclear explosion. But you spread the germs around in an explosion.

Dr. MESELSON. Let me put it this way: I certainly agree that you might kill an enormous fraction of the population with a biological weapon.

## STRATEGIC VALUE OF BIOLOGICAL WEAPONS

I also believe, however, that as strategic weapons go, these are ridiculous weapons, ridiculous because they in no way would reduce the ability of the country attacked to retaliate with nuclear missiles, and they also might not work.

You point out if the United States were attacked, we might not know who attacked us, but the problem of the enemy is a little different. Their problem is that the United States might know who attacked them or might assume who is was. In that case, they would be facing the United States with all of its gigantic nuclear might fully intact. It seems to me it would be absolutely lunatic to launch a biological warfare attack on a nuclear power.

The CHAIRMAN. Is it any more lunatic than launching a nuclear war? They are both lunatic.

Dr. MESELSON. I just meant to point out that a biological weapon does not have any counterforce capability and that it is highly unreliable. It does not damage the other side's retaliatory capability. You do not damage Soviet missiles with biological weapons nor they our missiles with their biological weapons.

Senator SYMINGTON. Interesting. You get to the question of graduation, if you are not in a nuclear war and have no agreement on other things. Some might attempt it on a relatively modest scale, take a tap at Berlin or something. They might attack crops; then there might be an argument as to who did or didn't do it, and you would have to prove it. You wouldn't hear any explosion at all at high altitude.

Dr. MESELSON. As you go down the scale, the opportunities for smaller scale offensive actions with BW becomes realistic, but if you are talking about major strategic threats among nuclear powers, I think biological weapons are useless and foolish.

## STRATEGIC VALUE OF A CHEMICAL OR BIOLOGICAL WEAPON

The CHAIRMAN. Would you say the same about a chemical weapon?

Dr. MESELSON. Yes.

The CHAIRMAN. Even with instant death?

Dr. MESELSON. Yes, for the reason that chemical attack would leave nuclear weapons intact. Also, it takes, weight for weight, a lot more for a chemical than a nuclear weapon.

The CHAIRMAN. It does?

Dr. MESELSON. Yes.

Again, the chemical weapon does not destroy the enemy's missiles, presuming they are in air-conditioned shelters. They are not good strategic weapons unless you don't have any nuclear weapons. For powers lacking nuclear weapons, it is a different story. These weapons, in my opinion, hold certain advantages for poor countries, small countries, who might not have nuclear weapons—but not for nuclear powers.

The CHAIRMAN. Let's assume there is a nuclear exchange. And let's assume, for purposes of argument, that the Russians would like to take over the United States, which some people believe. Not destroy its factories, its real estate, or its physical properties, but just get rid of the people. If that is their objective, this would be the way to do it.

Dr. MESELSON. Does anyone seriously believe that our strategic forces would remain unused in a case like that?

The CHAIRMAN. I was assuming they could find a way of delivering a chemical bomb without precipitating a nuclear war. I don't know whether they can or not. We haven't gotten to methods of delivery. You will have to enlighten us.

Go ahead, this is very interesting. I didn't have any idea what this was all about. Go ahead.

Senator CASE. Would you just keep in mind, Mr. Chairman, the possibility of this being considered as a retaliatory weapon rather than as a first strike weapon?

Dr. MESELSON. Yes.

Senator CASE. Might there not be some considerable importance to that? If a country had no nuclear retaliatory capacity, this might still provide a retaliation which would be a check against a first strike by the other side?

Dr. MESELSON. Yes.

The CHAIRMAN. Is that true?

Dr. MESELSON. I think for a country that has no nuclear weapons biological weapons—

#### EFFECTIVENESS OF AN ANTHRAX BOMB

The CHAIRMAN. The point, if I understand it, that he is making is this: we have been saying we are not going for a first strike, we have a defensive nuclear deterrent. We could say, then, "If you attack us we will really raise hell with you, and among other things we will use chemical weapons along with nuclear." You said that it takes more weight for chemical. What about biological? How would the equivalent weight, let's say, of anthrax delivered in Moscow, compare with the destructive capacity of nuclear weapons as far as the population is concerned?

Dr. MESELSON. Nobody can say today whether an anthrax bomb would work or not work.

The CHAIRMAN. Assuming it will work.

Dr. MESELSON. If it did work, then the amount required could be much less than the amount of nuclear material required to attack the same area. However, you still have the weight of the delivery vehicle to contend with, and when the vehicle weighs much more than the warhead, then fractional savings in the warhead size don't matter.

Thermonuclear weapons are already so compact and so lightweight that further reduction in warhead size that might be offered by biological weapons, especially keeping in mind that nobody can tell whether they would work or not, is not too meaningful.

The CHAIRMAN. They will be able to make them work as well as others, won't they?

Dr. MESELSON. No.

The CHAIRMAN. Why not?

Dr. MESELSON. Because the response of the human body to a microorganism is far more uncertain than the reaction of the human body to heat, blast and radiation. We can't be sure of the result of placing bacteria in a human lung. It can vary enormously. That bacterium is a living creature. It can be ill or well, you might say. It might be infectious or it might be harmless, depending on many things.

The CHAIRMAN. Change in hours might change its habits.

Dr. MESELSON. The atmosphere.

The CHAIRMAN. As it does us.

Dr. MESELSON. I wish to emphasize that biological weapons——

Senator CASE. There is a difference between biological and chemical agents.

Dr. MESELSON. Yes, chemicals are a different matter. The effects of chemical weapons are not as difficult to predict.

The CHAIRMAN. Go ahead.

#### POTENTIAL ANTICROP BIOLOGICAL WEAPONS

Dr. MESELSON. Not considered in FM3-10 are the potential anticrop biological weapons. Chief among these are rice blast and wheat rust. These are fungal diseases of rice and wheat that cause considerable damage to crops in the world today. Their effectiveness in any given application would be difficult to predict, due to variable resistance of different plant strains and other technical factors. Potentially, however, relatively small quantities of anticrop biological agents may be capable of devastating very large areas of cropland.

The CHAIRMAN. Because once it gets started it spreads.

Dr. MESELSON. It spreads, and very little might be needed on each plant, so little that if it really worked you wouldn't need much to cover a big area.

Senator CASE. Sparrows and starlings or things like that, or the gypsy moth.

Dr. MESELSON. Fungi, of course, are very much smaller objects, tiny particles adrift in the air, spores.

If I were to continue with this prepared testimony, Senator, it would [deleted] be a rather general discussion of the policy implications of chemical or biological weapons.

The CHAIRMAN. Go ahead, it is now to me.

#### GENEVA PROTOCOL OF 1925

Dr. MESELSON. Half a century has passed since the world's only major outbreak of poison gas warfare. Large-scale germ warfare has never been attempted. Gas and germ warfare are explicitly prohibited by international law in the Geneva protocol of 1925.

The CHAIRMAN. Did we sign that?

Dr. MESELSON. We signed it but did not ratify it. I would like to describe the history of that protocol.

The CHAIRMAN. I wish you would. We are only signatories; we did not ratify.

Dr. MESELSON. We did not ratify.

The CHAIRMAN. How many did?

Dr. MESELSON. Over 60 now. All members of the NATO alliance except ourselves, all members of the Warsaw Pact, Communist China, all of the industrial powers except us and Japan.

The CHAIRMAN. Including Russia?

Dr. MESELSON. Including Russia.

Senator CASE. Is it regarded as being in force among those nations that did sign it?

Dr. MESELSON. Yes it is, and some U.S. officials have expressed the opinion that it now constitutes conventional international law binding even on those countries which have not ratified it. I am not sure if that is the unanimous opinion of experts in this field.

The CHAIRMAN. Will you come back to that later?

Dr. MESELSON. I will come back to show—

The CHAIRMAN. All right, go ahead.

#### CONSIDERATIONS BEARING ON FORMATION OF CB WEAPONS POLICY

Dr. MESELSON. Considering the enormous scale of gas warfare in World War I, it is remarkable how well the protocol has been respected. There have been only two instances of verified poison gas warfare since 1925—in Ethiopia, that was the use of mustard gas by Mussolini against the Ethiopians in the 1930's and in the Yemen. In Vietnam, the United States has been employing a powerful but generally nonlethal antiriot agent, maintaining that the protocol does not forbid it.

When compared with the recent history of other forms of warfare, the record shows that the governments and peoples of the world have come to practice and expect a degree of restraint against the use of chemical and biological weapons not found for any other class of weapons, except nuclear ones. The chief factor justifying that restraint is the same for both nuclear and CB warfare—apprehension that, once begun, it would open up an unfamiliar and highly unpredictable dimension of warfare that might lead to the extermination of very large numbers of troops and civilians, especially one's own.

#### DESTRUCTIVENESS OF CBW

Destructiveness of CBW. There is no doubt that existing nuclear weapons would destroy entire populations. Although the performance of chemical and biological weapons in any particular attack would be less predictable than that of nuclear weapons, they too have very great potential for mass killing. The most effective method of strategic CBW attack would presumably entail the production, by bombers or missiles, of a cloud of toxic or infectious material over or upwind from a target to be inhaled or absorbed through the skin by persons in the attacked population. Although masks, protective suits and special shelters can provide effective protection against known chemical and biological agents, the cloud would readily penetrate dwellings and other ordinary structures.

The CHAIRMAN. Could you say that about a bomb shelter, too?

Dr. MESELSON. If the bomb shelter were air conditioned it would be secure. If it were not air conditioned, if the air is not filtered, it would not be secure.

The CHAIRMAN. Would an ordinary air conditioner filter it out or would it have to be a special filter?

Dr. MESELSON. A special filter would be required.

The CHAIRMAN. Which do not now exist in ordinary places?

Dr. MESELSON. No, they do not.

An attack by a single bomber dispensing one of the more deadly nerve gases could kill most unprotected persons within an area of at

least 5 square miles, this being the size of the zone of high mortality caused by the Hiroshima and Nagasaki atomic bombs.

Senator CASE. How long did that attack take?

Dr. MESELSON. How long before the deaths resulted?

Senator CASE. No, how long would the attack take? Would it have to drop only one thing or would it have to go back and forth over the target?

Dr. MESELSON. If one had bombs designed to release many little bomblets, as they are called, then it might not require going back and forth. If a spray tank were used it would require spraying a long line which the wind would then carry over the target.

Going back and forth, if you can produce a line of spray, wouldn't be necessary.

Senator MCGEE. What would be the time, Doctor, then, to follow up the interpretation of his question originally, before its impact would be registered?

Dr. MESELSON. I would say something like an hour before the full casualty level was reached, but many deaths would occur sooner.

#### EFFECT OF WEATHER CONDITIONS

It also depends on the wind. If there is no wind, the gas cloud is stationary. For persons within the cloud, each breath brings in an additional dose so that even a relatively low concentration of gas can kill, over time. If there is a high wind so that the cloud passes by quickly, then either one gets a lethal dose in those few minutes or the cloud is gone and one does not have a lethal dose. The effects of biological and chemical weapons depend very much on winds and weather.

Senator MCGEE. May I say, as I am sure the Chairman has already observed, this gives you an eerie, creepy feeling that just, rational men would be talking here in these terms. It makes it sound like the science fiction that we used to make fun of not very many years ago.

Dr. MESELSON. True. But I believe, Senator, that it is very important for civilians, and especially for the Congress, to review our chemical and biological weapons programs and policies.

Senator MCGEE. I understand that. That is why it is wise we are having this dialog here. I merely say it gives you a creepy feeling.

The CHAIRMAN. Go ahead, sir.

#### TOXINS

Dr. MESELSON. Although nerve gases are among the most poisonous substances known to be suitable for military use, it may well be possible to devise weapons containing far more poisonous materials, perhaps toxins or related substances. Toxins are poisons made by living creatures, such as bacteria. An example is Botulinus toxin.

The CHAIRMAN. What is that?

Dr. MESELSON. Botulism is a disease caused by a protein, a toxin, made by a bacterium which you can grow in spoiling food. There was an outbreak of botulism caused by spoiled tuna fish in Tennessee a few years ago.

The CHAIRMAN. Is it deadly?

Dr. MESELSON. It is highly deadly.

The CHAIRMAN. What is the difference between it and a germ, why do you call it a toxin?

Dr. MESELSON. It is a chemical made by a germ. It is not living, it is a product.

The CHAIRMAN. It is not living?

Dr. MESELSON. It is not living. It is a product made by a germ, a poisonous product made by a germ.

Senator CASE. How does it operate on the human body?

Dr. MESELSON. It is a nerve poison.

Senator CASE. Nerve poison?

Dr. MESELSON. Yes.

The CHAIRMAN. How do you distinguish it from a nerve gas, just because of its origin?

Dr. MESELSON. Yes.

Senator AIKEN. Just like bugs make honeydew. It is a good sounding name but it is still bug juice.

The CHAIRMAN. I didn't know what that word meant. I thought it meant just a poisonous substance.

Dr. MESELSON. No, a toxin refers to a poisonous substance made by a living organism. A poisonous substance made by a rattlesnake is called a toxin and poisonous chemicals made by fish are called toxins.

The CHAIRMAN. I see.

#### MEANING OF TERM "NERVE GAS"

Senator CASE. Just to refresh my memory, what does nerve gas mean?

Dr. MESELSON. The term "nerve gas" is used to describe the class of phosphorous-containing poisons first developed by Germany in World War II. These act to poison the nerves of the human body and they cause death. They can be synthesized in factories. They are not produced by living organisms. They are rather like some commonly used insecticides but much more powerful.

Senator CASE. Do they kill these nerves that we have?

Dr. MESELSON. Yes.

The CHAIRMAN. Almost instantaneously.

Dr. MESELSON. Yes, the nerve gases kill almost instantaneously.

Senator CASE. How is it done? By causing an explosion of the cells or how?

Dr. MESELSON. It works this way. When a nerve impulse travels to a muscle to tell the muscle to contract, something has to turn the impulse off, to tell the muscle to stop contracting. Nerve gas poisons the mechanism by which the impulse is turned off. Death due to nerve gas results from the simultaneous contraction of all muscles in the body.

The CHAIRMAN. You are just tied up in a knot?

Dr. MESELSON. That is right.

Senator CASE. I have to have this explained once every 2 months, I keep forgetting.

So it actually makes the victim appear to be in paroxysms?

Dr. MESELSON. Spasms, yes, although I had not planned to go into that.

The CHAIRMAN. Why not? It is interesting. I had never heard this explanation before. I didn't know what a nerve gas did.

Senator CASE. I remember you talked to us about this before, but it goes out of my head.

The CHAIRMAN. When did he talk to you about it?

Senator CASE. He had lunch one time with a group of younger members of the Senate, Bill. We were going to get into it and we did start, I believe, at that luncheon.

#### HOW BOTULISM OPERATES

The CHAIRMAN. Go ahead, it is very educational. I didn't know that was the way nerve gas operates. How does a botulism operate, what does a toxin do?

Dr. MESELSON. How botulism works is less well understood. People go into a sort of trance as a result of botulism poisoning and ultimately die but it is a much slower process unless the dose is very high.

The CHAIRMAN. But you don't know any cure for it once you are exposed or get it?

Dr. MESELSON. There is a possibility of the administration of antiserum against it once you have got it. How effective this is, I don't know. Botulism isn't too common.

I believe that when some persons ate poisoned tuna fish in Tennessee not long ago, they were given antiserum. I don't think anybody was saved.

The CHAIRMAN. Did they die?

Dr. MESELSON. I am not certain, but I believe they died except for one elderly lady who survived, who may have eaten less of it. [Deleted.]

The CHAIRMAN. This is an area that is rather hard to carry on by laboratory experiments. One doesn't find subjects willing to try it.

Senator CASE. I was going to ask you about that. Do the armed services go into this with animals?

Dr. MESELSON. Yes, extensive animal experiments are conducted and it is also possible to do experiments on human volunteers if therapy is ready at hand to treat them.

The CHAIRMAN. There are a number of rhesus monkeys they are working on at Detrick now. They have to use very special monkeys, that cost \$75 apiece, which come from India. I suppose this is because they are most similar to humans, is that right?

Dr. MESELSON. Yes. Conscientious objectors often volunteer for experimental purposes, and there is even a society of those who have done so. They have a newsletter.

The CHAIRMAN. What do they call them?

Dr. MESELSON. Many of them are Seventh Day Adventists. I have forgotten the name of their group.

The CHAIRMAN. And they serve as guinea pigs for this purpose?

Dr. MESELSON. Yes.

The CHAIRMAN. Why do they do that? Do they wish to promote the understanding of these diseases? Do they feel it will serve the cause of peace?

Dr. MESELSON. I don't know.

Senator CASE. It isn't limited only to this, it is all kinds of medical research.

The CHAIRMAN. Not just germ warfare?

Senator AIKEN. Radiation can kill virus.

Dr. MESELSON. Yes.

Senator AIKEN. But not botulism.

Dr. MESELSON. A fantastic dose of radiation could.

#### VIRUSES

The CHAIRMAN. We haven't come to viruses yet. Are they toxins?

Dr. MESELSON. No. Viruses are germs.

The CHAIRMAN. Do you come to those later?

Dr. MESELSON. They are included among the agents I mentioned earlier. For example, Venezuelan equine encephalitis is caused by a virus.

The CHAIRMAN. I see.

Dr. MESELSON. And that is a—

Senator McGEE. Is it incapacitating in other ways [deleted] or just discomforting?

Dr. MESELSON. It is highly incapacitating. In nature, it [deleted] is transmitted to man by mosquitos.

Senator McGEE. I see.

Dr. MESELSON. It is thought to be nonlethal, but, Senator, nobody can say with confidence what would happen if humans were exposed to Venezuelan equine encephalitis in the form of an aerosol. [Deleted.]

The point is that when administered through the lungs, it could be lethal. [Deleted.]

The CHAIRMAN. Congressman McCarthy, this is a very informal meeting, a kind we don't usually have. If you wish to ask questions, you are free to do so. You are a pioneer in this area so far as the Congress is concerned. Do you have any questions you want to ask? You know all of this, I imagine.

Mr. MCCARTHY. Not really, I am learning a great deal more.

The CHAIRMAN. So am I, but if you have a question that bothers you, please ask it.

#### EFFECTS OF TEAR GAS

Senator CASE. Bill, would it be helpful to describe just briefly the characteristics of the other main thing, that is the tear gas and its effects, its operation as distinguished from the other?

The CHAIRMAN. He described that.

Senator CASE. Did you?

The CHAIRMAN. He said two of the standard agents are tear gases.

Senator CASE. How they operated in the body as opposed to the way nerve gas does?

The CHAIRMAN. All right. What does it do?

Dr. MESELSON. Well, ordinary tear gas is called a lacrimator because it causes intense tearing and irritation to the mucuous membranes. This is the way it acts—by causing intense irritation to the skin and membranes. The same is true for the riot agent CS, the one that is used in Vietnam. The so-called riot agent DM, which is also called Adamsite, is a different matter. It is a poison, and it can cause violent vomiting and nausea. It is not approved for riot control use under conditions where details are not acceptable.

Senator CASE. What is mace?

Dr. MESELSON. Mace contains ordinary tear gas, CN. That is its active ingredient.

Senator CASE. Just a heavier dose?

Dr. MESELSON. It is a heavy dose because it is contained in a liquid solvent that can form a jet that impacts directly on the face. Before normal instincts tell you not to inhale, you may have already got a lungful of it.

Senator CASE. Except for some unusually susceptible people, or people who are suffering from something, it is not ordinarily lethal?

The CHAIRMAN. Doctor, let's see. This is very interesting and this takes time.

Senator AIKEN. This is not classified.

The CHAIRMAN. This particular questioning is, but not his statement. Go ahead, Doctor.

#### EFFECTS OF BIOLOGICAL WEAPONS

Dr. MESELSON. Yes. Although nerve gases are among the most poisonous substances known to be suitable for military use, it may well be possible to devise weapons containing far more poisonous materials, perhaps toxins or related substances. Weapons based on such superpoisons might become as destructive to unprotected populations as thermonuclear weapons of equal size.

Poisonous as nerve gases are, virulent micro-organisms and viruses can be a million or more times more so, in terms of the amount that can cause incapacitation or death. Although many infectious agents are rapidly inactivated or lose their virulence when dispersed in the atmosphere, this obstacle to the development of biological weapons can probably be circumvented or overcome with sufficient research effort. If so, biological weapons could surpass thermonuclear bombs, in terms of the area coverage possible for a weapon of specified size. However, even after very extensive research, the performance of biological weapons is likely to remain subject to great uncertainty. Their effects would depend in large measure on poorly understood and highly variable factors that determine man's resistance to infection. A biological attack intended to be highly lethal might actually kill very few persons, and, conversely, an attack expected only to cause temporary incapacitation could cause high mortality.

Although biological warfare agents might be chosen from among those that are not highly contagious under natural circumstances, this would not preclude the unexpected initiation of a widespread epidemic under the very unnatural conditions inherent in military use. Indeed, it is possible that bacteria or viruses disseminated in an aerosol cloud could subsequently emerge from the exposed population of humans, insects, birds, rodents, or other animals with increased persistence, contagiousness, and virulence to man. Large-scale operations in regions populated by many persons or animals would be more risky than small operations in desolate places, and viruses might be more hazardous than bacteria. However, we cannot evaluate the risks with any confidence in any of these situations. Therefore, the field testing of live biological weapons, and especially the outbreak of actual biological warfare, would constitute a menace to the entire human species.

[Deleted.]

## REVIEW OF CBW POLICIES NEEDED

Mr. McCARTHY. Senator, I wonder if I could, on this earlier point that Dr. Meselson made—in a meeting I had with Dr. Meselson, I asked someone from the executive branch if there had been a high level review of the total picture of our chemical and biological warfare policies in recent years, and he said to his knowledge there had not been except for the use of tear gas. I might say there, too, just to supplement what you said, that we have a letter from Deputy Secretary Vance to Congressman Kastenmeier in 1965 that states that three agents were shipped to Vietnam and that they were used on X, Y, and Z dates; and the places were mentioned also, and they included the more basic Adamsite which is called—

Dr. MESELSON. DM.

Mr. McCARTHY. DM.

The CHAIRMAN. Go ahead.

Dr. MESELSON. I would like to express the feeling that in a way the Defense Department is given a really impossible job, to guarantee the security of the United States of America. In today's world nobody can guarantee the security of a country. Even if they try their best there are going to be unanswerable or almost unanswerable questions.

The CHAIRMAN. When were they given this job of guaranteeing our security, and especially an exclusive guarantee, because I detect from the Secretary of Defense's attitude that he believes he has some very special responsibility quite different from the Members of the Senate in regard to security. I didn't know the Defense Department had to guarantee it absolutely. I agree with you it is impossible, but the task goes far beyond just military means.

Dr. MESELSON. I should think that in performing their tasks they could only be helped by the kind of independent review which is available from concerned citizens and from the Congress, and, in that spirit, I believe that the United States could do itself far more harm than good by continuing some of its programs, some of its policies, in this area of chemical and biological weapons.

The CHAIRMAN. I agree.

Dr. MESELSON. That is the spirit of my comments.

The CHAIRMAN. I agree with that completely.

Senator AIKEN. Can I ask a question? Do you know of any virus that attacks both plant and animal life alike, a single virus?

Dr. MESELSON. I cannot think of any virus that attacks both man and plants.

Senator AIKEN. I know that if you take plants of different varieties of the same species, one will be very susceptible to a virus and another variety of the same species will be immune to the same virus.

Dr. MESELSON. Absolutely.

Senator AIKEN. And I think you might learn something from studying those plants.

Dr. MESELSON. Yes.

There are some viruses that attack insects and plants, and insects are animals. So, yes, there may conceivably be some viruses that attack both higher animals and plants. But I do not believe that any are known today.

## UNCONTROLLABILITY OF CHEMICAL AND BIOLOGICAL WARFARE

I would like to make some remarks about the uncontrollability of chemical and biological warfare.

A major uncertainty in predicting or controlling the course of CBW, once it is begun, would arise from the great variety of possible weapons and targets, from the incapacitating to the highly lethal and from the local battlefield to entire continents. Once begun at any level in earnest, it would be very difficult to predict how far CBW might go. Distinctions and stopping places would be very difficult to define and to keep. The preparations and training required for one form of CBW would facilitate and therefore tempt escalation to larger scale and more deadly CBW operations. The breakdown of barriers to weapons once regarded as illegal and peculiarly uncivilized can inspire and encourage methods of warfare even more savage than those underway at the time.

The vulnerability of troops or civilians to CBW attack depends very much on the availability and effectiveness of protective facilities, the rigor of defensive training and discipline, and the performance of early-warning systems. All of this may act to place an unusually high premium on surprise or clandestine attack and on the use of novel or unexpected agents or means of dissemination. Once the effect of surprise has worn off, however, and defensive precautions have been instituted, CB warfare might continue on a large scale but with relatively inconclusive effects until new weapons are introduced or until conventions against the attack of previously inviolate targets are transgressed.

The difficulty of allowing the limited employment of gas without running the risk of bringing the whole chemical and biological arsenal into use has been concisely stated by T. C. Shelling in his book *Arms and Influence* (Yale University Press, 1966), and to quote Mr. Shelling:

Some gas raises complicated questions of how much, where, under what circumstances; "no gas" is simple and unambiguous. Gas only on military personnel; gas used only by defending forces; gas only when carried by projectile; no gas without warning—a variety of limits is conceivable . . . But there is a simplicity to "no gas" that makes it almost uniquely a focus for agreement when each side can only conjecture at what alternative rules the other side would propose and when failure at coordination on the first try may spoil the chances for acquiescence in any limits at all.

## GENEVA PROTOCOL PRINCIPLES GENERALLY UNDERSTOOD

These principles appear to have been understood by the leaders of both sides in World War II, during which neither lethal nor non-lethal gases were employed. At the outbreak of the war, both sides exchanged assurances that they would observe the Geneva Protocol of 1925, that is, Germany, France, and Britain, exchanged such assurances.

Later when the United States became involved in the war, President Roosevelt declared in 1943:

Use of such weapons has been outlawed by the general opinion of civilized mankind. This country has not used them and I hope that we never will be compelled to use them. I state categorically that we shall under no circumstances resort to the use of such weapons unless they are first used by our enemies.

Although many rules of war were violated in that conflict, it is fortunate for all sides that the rule against gas was observed. Germany

had secretly developed and produced a large quantity of nerve gas. Although the Allies had no weapon of comparable deadliness, they could have produced vast quantities rather soon after becoming aware of its existence. Since the previous restraints against anticity warfare had already broken down, the introduction of nerve gas in the midst of World War II would almost certainly have caused a death toll vastly greater than it was.

I feel, Senator, that I perhaps should now depart from this prepared testimony, because I would like to talk about U.S. policy from the time of World War II until the present regarding chemical and biological weapons and I fear that since time is passing I should move to that subject now.

The CHAIRMAN. All right. The remainder of your statement will be included in the record at this point.

(The balance of Dr. Meselson's statement follows:)

Chemical and biological weapons by their very nature are suited to the attack of large areas; their natural targets are people rather than military equipment; important military personnel can be equipped and trained to use protective devices far more easily than can civilians. For all of these reasons, civilians are the most natural and most vulnerable targets for CBW attack. If the barriers against CBW are broken down, civilians are likely to become its main victims.

#### THE MYTH OF HUMANE CBW

It is well known that some chemicals such as tear gas are able to incapacitate a man for a short time with little risk of killing. Some people have concluded from this that the introduction of non-lethal chemicals and even of biological weapons thought to be non-lethal might actually make war more humane. The argument has shown considerable appeal both for thoughtless zealots who wish to advance the practice of CBW in any form and also for persons who genuinely hope to make war less savage. Although it is true that some chemical warfare agents are relatively non-lethal in themselves, it seems to me almost certain that their use would definitely not make wars on the whole less savage and would in fact risk making them much more so, should it trigger the use of lethal CB weapons.

It is naive to expect that in a real war non-lethal agents would be used by themselves. Once introduced into a combat area, the pressure would be very great to utilize them in any manner that increased the overall effectiveness of general military operations. Non-lethal chemical weapons would be used to increase the effectiveness of lethal ones. Tear gas can reduce the accuracy of enemy rifle fire, allowing one's own forces to approach more closely, increasing the accuracy and intensity of their counterfire. It can be used to force men out of protective cover and into the line of fire or the path of bomb and shell fragments. Under the desperate pressures of a war fought with artillery, bombs, napalm, and other lethal weapons, it is only reasonable to expect that "non-lethal" weapons once introduced will come to be used in order to kill. This has happened in Vietnam where U.S. forces have spread riot gas over large areas to force persons from protective cover to face attack by fragmentation bombs. It happened in World War I when both sides used tear gas and other non-lethal chemicals in grenades and artillery shells to facilitate conventional infantry and artillery operations.

In any case, if tear gas or similar agents should prove at all effective when first used both sides would introduce protective devices and tactics, making subsequent use of such agents much less effective. Thus, except perhaps when they are first introduced, non-lethal chemical weapons are unlikely to have much effect except to set the stage for more deadly CBW operations.

The conduct of non-lethal CBW can greatly facilitate preparations and training for the use of lethal chemical and biological agents. When combatants learn to protect themselves against the effects of mild or 'conventional' agents the temptation will be strong and the means will be at hand to experiment with more deadly ones. During the first year of World War I both sides used tear gas and other harassing agents until the German introduced lethal chlorine gas. Following that, both sides tested a large number of poison gases seeking to find

ones that would be decisive in battle. The first attack with poison gas had a devastating effect. The Allied front was broken, and 5,000 of the 15,000 gas casualties died. However, even though more effective gases were introduced in great quantity by both sides, advances in defensive preparations prevented gas from being a decisive weapon in World War I. Advocates of "humane" gas warfare often point out that, at least toward the end of World War I, gas produced casualties with proportionately less mortality than did high-explosive weapons. However, this was not because commanders on both sides wished to fight without killing, but rather because the most effective gases then known caused more wounds than deaths. Modern nerve gases are vastly more lethal than the old World War I gases. Can anyone have much confidence that skin-penetrating nerve gas would not have been used in World War I had it become available in 1917?

#### CHEMICAL AND BIOLOGICAL WEAPONS AND MINOR POWERS

The development and initial production of a new weapon usually requires much greater sophistication and effort than is needed to reproduce a weapon already possessed by another. The accessibility of chemical and biological weapons to smaller powers will depend very much on the CBW programmes of great powers and, for a limited time, on measures to keep the results of those programmes secret. With chemical and biological weapons as with other weapons, great powers will probably lead the way unless they deliberately refrain from doing so.

The chemical compositions of several nerve gases are published in the open literature, and detailed manufacturing procedures could be specified by competent chemists and chemical engineers. Although no thorough cost-analysis has been published, it would appear that a considerable number of smaller nations could produce and integrate nerve gas weapons into their artillery and air forces without great economic strain. Commercial transport aircraft could be modified without great difficulty to drop or spray the gas. No small power is definitely known to produce nerve gas or to have been supplied with it by another, although there have been newspaper reports that Egypt has used a nerve gas on a small scale in the Yemen conflict.

The acquisition of nerve-gas weapons would greatly increase the destructive potential of a small nation's military forces, but it might also greatly reduce its overall security by provoking its neighbours to arm themselves similarly. This they might do by producing the gas themselves or by demanding it from their great power allies. If nerve gas warfare should ever break out between two small states, the population of one or both could be largely annihilated within a short space of time, and the intense feelings provoked around the world might well ignite a much larger conflict.

The attempt to develop biological weapons of reasonably assured characteristics would require a costly and technically sophisticated effort and an elaborate testing programme. Indeed, only use in war itself would provide the kind of information that responsible military men would require before placing much reliance on a radically new type of weapon. It seems unlikely that a small power would attempt the development of biological weapons except perhaps as a deterrent threat. However, this would be an extremely risky posture for a small power unless large powers had already legitimized the possession and threatening display or use of biological weapons.

#### WHY SINGLE OUT CBW FOR SPECIAL PROHIBITIONS?

As long as wars continue to be fought with high explosive weapons and napalm, what sense does it make to maintain special constraints on CBW? The question is understandable, but it seems to me that some substantial answers are contained in the remarks above. We realize that special rules are required for nuclear weapons. The distinction between conventional weapons and nuclear ones of any size is a real one, and the importance of maintaining it is generally understood. Chemical and biological weapons share with nuclear ones the attribute of potentially overwhelming destructiveness. Biological weapons could pose a threat to the entire human species. Both chemical and biological weapons place a high premium on clandestine and surprise attack, thus lessening stability. Once developed, chemical and biological weapons can be exceedingly cheap, relatively easy to produce, and quick to proliferate. They would threaten civilians especially. Their use would violate the oldest major arms control treaty now in force.

## PREVENTING THE USE OF CHEMICAL AND BIOLOGICAL WEAPONS

It is important for nations to understand that it is in their long-term interest to prevent the use of chemical and biological weapons. A relatively clear and unique standard to guide both the practice and the expectations of nations is provided by the Geneva Protocol of 1925. The Protocol has been ratified by all major powers except Japan and, ironically, the nation which proposed it at Geneva—the United States. Many of the states organized since World War II, including the People's Republic of China and both Republics of Germany, have ratified the Protocol or have agreed to be bound by the ratification of their predecessors. Less than two years ago, in December, 1966, the General Assembly of the United Nations passed without opposition a resolution calling for strict observance of the Geneva Protocol and appealing for universal accession to it. The United States and Japan voted in support of the General Assembly resolution along with 89 other states. It is important to secure the actual ratification of Japan, the United States, and other nations that have not yet ratified the Protocol. Means should be found to make clear that viruses as well as bacteria and non-lethal as well as lethal chemical and biological weapons are meant to be included under its prohibition. But great care must be exercised to make sure that attempts to further clarify the scope of the Protocol do not result in weakening its universal authority.

The Geneva Protocol is a no-first-use agreement. It does not prohibit CB weapons production, nor does it prohibit reprisal in kind. Last July, the United Kingdom submitted to the Eighteen-Nation Disarmament Conference in Geneva a proposal concerning biological weapons that goes well beyond the Geneva Protocol. Under the terms of the British proposal, states would undertake not to engage in germ warfare of any kind under any circumstances. In addition, the production of germ weapons would be prohibited under terms yet to be worked out in detail. A copy of the U.K. proposal is appended, as well as a copy of The 1925 Geneva Protocol.

TABLE V. HYPOTHETICAL ANTIPERSONNEL BIOLOGICAL AGENTS AND DELIVERY SYSTEMS

## A. HYPOTHETICAL ANTIPERSONNEL BIOLOGICAL AGENTS

Agent	Symbol	Time required to produce casualties (days)	Percentage of deaths	Length of incapacitation (days)	Time of effectiveness		Physiological effects
					Day (hours)	Night (hours)	
Lugo fatigue.....	AA	2-3	0-10	( <sup>1</sup> )	2	3	Incapacitating disease of long duration; sores in the nose and throat.
September fever.....	BB	1-3	2-3	6-10	1	3	High fever, muscular aches, vomiting, diarrhea, and extreme prostration.
Toledo infection.....	CC	1-3	90-100	NA	10	10	High fever, glandular swelling, coughing, pneumonia, and sores on the skin.

<sup>1</sup> 3 months.

## B. HYPOTHETICAL DELIVERY SYSTEMS

System	Max range (Kilometers)	HOB	Area coverage		Percentage of casualties		
			Square Kilometers	Dimensions (Kilometers)	Lugo fatigue	September fever	Toledo Infection
Guided missile (medium)...	75	High.....	100	15.7	70	25	60
		Low.....	50	13.5	90	50	80
Guided missile (heavy)...	150	High.....	200	18	70	25	60
		Low.....	100	15.7	90	50	80
Fighter aircraft (spray)...	( <sup>2</sup> )	NA.....	1,000	50x20	60	25	50
		Low.....	100	15.7	90	50	80

<sup>1</sup> Radius.<sup>2</sup> Variable.

Note. To be used for instructional purposes only.

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

The text of the substantive part of the protocol reads as follows:

"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; and,

"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;

"Declares:

"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 United States delegation at Geneva proposed the ban on gas, and the Polish delegation suggested that this be extended to include bacteriological weapons. The protocol is in force with respect to most countries, including the United Kingdom, France, the Federal Republic of Germany, Italy, the Peoples Republic of China, and the U.S.S.R. The United States and Japan signed but did not ratify the protocol. Although the protocol was favorably reported by the Committee on Foreign Relations, the United States Senate in 1926 referred the report back to committee without giving its advice and consent to ratification.

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RESOLUTION ADOPTED BY THE GENERAL ASSEMBLY OF THE UNITED NATIONS

*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 adopted and is recognized by many States,*

*Noting that the Conference of the Eighteen-Nation Committee on Disarmament 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 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.*

*148th plenary meeting,  
5 December 1966.*

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CONFERENCE OF THE EIGHTEEN-NATION COMMITTEE ON DISARMAMENT

6 August 1968.

UNITED KINGDOM

WORKING PANEL ON MICROBIOLOGICAL WARFARE

The United Kingdom Delegation consider that the 1925 Geneva Protocol is not an entirely satisfactory instrument for dealing with the question of chemical and microbiological warfare. The following points may be noted:

(i) Many states are not parties to the Protocol and of those that are parties many, including the United Kingdom, have reserved the right to use chemical and bacteriological weapons against non-parties, violators of the Protocol and their allies.

(ii) Jurists are not agreed whether the Protocol represents customary international law or whether it is of a purely contractual nature.

(iii) Even if all states were to accede to the Protocol there would still be a risk of large-scale use of the proscribed weapons as long as states have the right to manufacture such weapons and to use them against violators and the allies.

(iv) There is no consensus on the meaning of the term "gases" in the phrase "asphyxiating, poisonous or other gases and all analogous liquids, materials or devices". The French version of the Protocol renders "or other" as "out similaries" and the discrepancy between "other" and "similaries" has led to disagreement on whether non-lethal gases are covered by the Protocol.

(v) The term "bacteriological" as used in the Protocol is not sufficiently comprehensive to include the whole range of microbiological agents that might be used in hostilities.

(vi) The prohibition in the Protocol applies to use "in war". There may therefore be doubt about its applicability in the case of hostilities which do not amount to war in its technical sense.

2. It is not to be expected that all these difficulties can be easily or speedily resolved. The United Kingdom Delegation suggest, however, that the problem might be made less intractable by considering chemical and microbiological methods of warfare separately. The Geneva Protocol puts them on an identical basis, but—

(i) As indicated in paragraph 1(iv) above, there is disagreement on whether the ban covers all agents or only lethal ones. It would be extremely difficult to secure agreement on a new instrument banning the use of all agents of chemical warfare, particularly as some of those agents have legitimate peaceful uses for such purposes as riot control.

(ii) Chemical weapons have been used on a large scale in war in the past and are regarded by some states as a weapon they must be prepared to use if necessary in any future war, particularly as they fear they may be used against them. In any event, at the moment, they would be reluctant to give up the manufacture of chemical agents and the right to conduct research etc., in this field.

3. The United Kingdom Delegation recognizes that verification, in the sense in which the terms is normally used in disarmament negotiations, is not possible in either the chemical or the microbiological field. The difficulty, as far as the microbiological field is concerned, is that the organisms which would be used are required for medical and veterinary uses and could be produced quickly, cheaply and without special facilities either in established laboratories or in makeshift facilities. As far as chemical agents are concerned it seems unlikely that states will be prepared to forego the right to produce and stockpile such agents for possible use in war unless adequate verification procedures can be devised and applied and problems of definition etc. resolved. However, the use of microbiological methods of warfare has never been established, and these are generally regarded with even greater abhorrence than chemical methods. The United Kingdom Delegation therefore considers that in this field the choice lies between going ahead with the formulation of new obligations and doing nothing at all— in which case the risks and the fears of eventual use of microbiological methods of warfare will continue and intensify indefinitely.

4. The United Kingdom Delegation therefore proposes the early conclusion of a new Convention for the Prohibition of Microbiological Methods of Warfare, which would supplement but not supersede the 1925 Geneva Protocol. This Convention would proscribe the use for hostile purposes of microbiological agents causing death or disease by infection in man, other animals, or crops. Under it states would:—

(i) declare their belief that the use of microbiological methods of warfare of any kind and in any circumstances should be treated as contrary to international law and a crime against humanity;

(ii) undertake never to engage in such methods of warfare themselves in any circumstances.

5. The Convention should also include a ban on the production of microbiological agents which was so worded as to take account of the fact that most of the microbiological agents that could be used in hostilities are also needed for peaceful purposes. Thus the ban might be on the production of microbiological agents on a scale which had no independent peaceful justification. Alternatively, the Convention might ban the production of microbiological agents for hostile purposes, or it might ban their production in quantities that would be incompatible with the obligation never to engage in microbiological methods of warfare in any circumstances.

6. Whatever the formulation might be, the ban would also need to cover ancillary equipment specifically designed to facilitate the use of microbiological agents in hostilities. In addition, the Convention would of course need to include an undertaking to destroy, within a short period after the Convention comes into force, any stocks of such microbiological agents or ancillary equipment which are already in the possession of the parties.

7. The Convention would also need to deal with research work. It should impose a ban on research work aimed at production of the kind prohibited above, as regards both microbiological agents and ancillary equipment. It should also provide for the appropriate civil medical or health authorities to have access to all research work which might give rise to allegations that the obligations imposed by the Convention were not being fulfilled. Such research work should be open to international investigation if so required and should also be open to public scrutiny to the maximum extent compatible with national security and the protection of industrial and commercial processes.

8. In the knowledge that strict processes of verification are not possible, it is suggested that consideration might be given *inter alia* to the possibility that a competent body of experts, established under the auspices of the United Nations, might investigate allegations made by a party to the Convention which appeared to establish a *prima facie* case that another party had acted in breach of the obligations established in the Convention. The Convention would contain a provision by which parties would undertake to co-operate fully in any investigation and any failure to comply with this or any of the other obligations imposed by the Convention would be reported to the Security Council.

9. As regards entry into force of the Convention, the appropriate international body might be invited to draw up a list of states (say 10-12) that it considers most advanced in microbiological research work. The Convention might come into force when ratified by all those states and a suitably large number of other states.

10. Consideration should be given to the possibility of including in the Convention an article under which the parties would undertake to support appropriate action in accordance with the United Nations Charter to counter the use, or threatened use, of microbiological methods of warfare. If such an article were included it might be endorsed by the Security Council in rather the same way as the Council welcomed and endorsed the declarations made by the United States, the Soviet Union and the United Kingdom in connexion with the Non-Proliferation Treaty.

#### HAGUE CONVENTION OF 1899

Dr. MESELSON. At the outbreak of World War I, there was a treaty dealing with gas, the Hague Declaration of 1899, specifically prohibiting the use of asphyxiating or deleterious gas in projectiles.

In World War I, as you know, massive amounts of poison gas were used. It began with the use of tear gas by the French and other nonlethal gases by the French and Germans. It was Germany, however, which first introduced poison gas, namely chlorine gas, in the famous battle at Ypres. They did not use projectiles which had been prohibited by the Hague Convention.

The CHAIRMAN. It was only the use of projectiles, not the use of gas was that was prohibited?

Dr. MESELSON. The Germans responded that they had not violated the Hague Convention because the gas used was contained in cylinders and not projectiles. They also maintained that tear gas had been used previously by the French.

A great deal of gas both lethal and nonlethal was used in World War I.

#### 1922 CONFERENCE ON LIMITATION OF ARMAMENTS

In 1922, at the Washington Conference on the Limitation of Armaments a treaty was concluded on submarines and noxious gases. The article on gases was introduced by the United States, represented by Senator Elihu Root. This treaty on submarines and noxious gases prohibited the use in war of poisonous, asphyxiating or other gases, and all analogous liquids, materials, and devices. It was a no-first-use treaty prohibiting the use of poisonous, asphyxiating and other gases.

It received Senate ratification with no dissenting vote.

However, that treaty never came into force because France objected to a clause concerning submarines unrelated to the question of gas warfare.

#### GENEVA PROTOCOL OF 1925

In Geneva in 1925, at a conference that was initially to consider the commercial sale of arms, the United States again brought up the question of gas warfare. The question was put on the agenda, and what is now known as the Geneva Protocol of 1925 came about. The United States signed the Geneva Protocol in 1925 and it then came to the Senate for its advise and consent to ratification.

Part of the Senate debate was in closed session, and I know of no record of that. The open discussion of the protocol began with the reading of a letter from General Pershing. I read from the Congressional Record of December 10, 1926. General Pershing states in a letter to Senator Borah of the Foreign Relations Committee:

I cannot think it possible that our country should fail to ratify the Protocol which includes this or a similar provision. Scientific research may discover gas so deadly that it will produce instant death. To sanction the use of gas in any form would be to open the way for the use of the most deadly gases and the possible poisoning of whole populations of non-combatant men, women and children. The contemplation of such a result is shocking to the senses. It is unthinkable that civilization should deliberately decide upon such a course.

Sincerely yours,

JOHN J. PERSHING.

After the reading of the letter by General Pershing, however, the opponents of the Geneva Protocol presented arguments that gas as shown by the experience of World War I was a relatively humane weapon. It was claimed that only 2 percent of gas casualties died whereas a higher percentage of casualties due to shrapnel and high explosives died in World War I.

#### SENATE ACTION ON GENEVA PROTOCOL

As the debate developed, it appeared that the protocol did not have the necessary votes, and Senator Borah did not bring it to a vote.

The CHAIRMAN. It was not brought to a vote?

Dr. MESELSON. No. It was referred back to the committee. It was finally withdrawn from consideration by the Senate by President Truman many years later along with certain other pending matters.

I would comment on the considerations of 1926 by saying that the record shows that gas in World War I did cause a higher ratio of casualties to death than other weapons. There are some—

The CHAIRMAN. A higher ratio.

Dr. MESELSON. Yes, that is, there was less death per casualty caused by shrapnel, for example.

Senator AIKEN. Percentage-wise?

Dr. MESELSON. The opponents of the protocol claimed that about 2 percent of gas casualties died and 10 percent of other casualties.

Senator CASE. You mean disabled?

Dr. MESELSON. That is right.

Senator AIKEN. That would not be true today, would it?

Dr. MESELSON. That is the point, Senator. If a more deadly gas had been available during World War I, one could not have expected that the leaders of both sides would have refrained from using it. I would further point out that a report of the Surgeon General subsequent to the war stated that perhaps two-thirds or more of the so-called gas casualties were fictitious, because many men pretended gas casualties, or genuinely thought they had them, when they didn't. Such men were classified as casualties and hospitalized.

The CHAIRMAN. That was chlorine gas.

Dr. MESELSON. That was mainly mustard gas.

The CHAIRMAN. I would say chlorine.

Senator CASE. Mustard falls into which category?

Dr. MESELSON. Mustard is a currently standardized agent, and it is classed as a blister agent.

Senator CASE. It may be fatal but—

Dr. MESELSON. It may be fatal, but it is generally not considered a fatal but rather a seriously incapacitating gas.

The treaty nevertheless went into force. It has now been ratified by over 60 nations. Some of them in fact have ratified it since World War II.

The CHAIRMAN. Has it ever been suggested that we ratify it?

Dr. MESELSON. Yes, it has been discussed and I would like to discuss that point in a moment.

The treaty has been ratified, as I said I believe before, by all members of the Warsaw Pact, by Communist China, and by all members of the NATO alliance except ourselves. The treaty was supported by all of the interwar presidents, Coolidge, Harding, Hoover, Roosevelt.

The CHAIRMAN. It outlaws the use of any gas, whether in a projectile or otherwise?

Dr. MESELSON. The wording of the Geneva protocol is as follows, and it is appended as an appendix of my statement. (See p. 26.) It outlaws the use in war of asphyxiating, poisonous, or other gases, and of all analogous liquids, materials, or devices.

Now, the Geneva protocol is a no-first-use treaty. It does not outlaw research, development, or production of gas or biological weapons. It does not outlaw retaliation in case one is attacked.

#### U.S. POST-WORLD WAR II POLICY

The policy of the United States with regard to the prohibition on gas has been different at different times. In 1956 the policy of the United States, as stated in "Army Field Manual 27-10," page 18, this is 1956, was as follows:

The United States is not a party to any treaty now in force that prohibits or restricts the use in warfare of toxic or non-toxic gases, of smoke or incendiary materials or of bacteriological warfare. A treaty signed at Washington 6 February 1922 on behalf of the United States, the British Empire, France, Italy and Japan, contains a provision forever prohibiting the use in war of asphyxiating, poisonous, or other gases and all analogous liquids, materials or devices but that treaty was expressly conditioned to become effective only upon ratification of all the signatory powers, and not having been ratified by all the signatories has never become effective.

That was the Washington treaty. The Army Field Manual goes on to state:

The Geneva Protocol for the prevention of the use in war of asphyxiating, poisonous or other gases and bacteriological methods of warfare signed on 17 June, 1925 on behalf of the United States and many other powers has been ratified or adhered to by and is now effective between a considerable number of states. However, the United States Senate has refrained from giving its advice and consent to the ratification of the protocol by the United States and it is accordingly not binding on this country.

#### VIEW EXPRESSED BY STATE AND DEFENSE DEPARTMENTS

A similar view was expressed by the Departments of Defense and State in 1960 in response to a joint House-Senate resolution introduced by Congressman Kastenmeier in 1959. The Department of Defense and the Department of State sent letters to the chairman of the House Committee on Foreign Affairs. The Defense Department letter dated March 29, 1960, opposes the resolution. I might say that the resolution stated that its sponsors did not oppose research and development of chemical and biological weapons, did not oppose readiness to retaliate in kind if attacked, but did wish at a time when the budget was in fact rising steeply for chemical and biological weapons, to reiterate the policy stated by President Roosevelt that the United States would not use these weapons unless it was first attacked by its enemies. The Defense Department opposed this resolution stating as follows:

Similarly, declarations might apply with equal pertinency across the entire spectrum and no reason is conceived why biological and chemical weapons should be singled out for this distinction.

The letter goes on to develop that argument.

The Department of State in its letter of opposition to the resolution stated—

The CHAIRMAN. What year is that?

Dr. MESELSON. This letter is dated April 11, 1960.

The CHAIRMAN. Yes.

Dr. MESELSON (reading):

As a member of the UN, the United States, as are all other members, committed to refrain from the use not only of biological and chemical weapons but the use of force of any kind in a manner contrary to that organization's charter. Moreover, the U.S. has continued efforts to control efforts through enforceable international disarmament agreements. Of course, we must recognize our responsibilities toward our own and the free world security. These responsibilities involve, among other things, the maintenance of an adequate defensive posture across the entire weapons spectrum which will allow us to defend against acts of aggression in such a manner as the President may direct. Accordingly, the Defense Department believes the resolution should not be adopted.

I would emphasize again that the resolution did not oppose research, development, stockpiling or use of these weapons in retaliation. It asked only for the reiteration of our policy of no-first-use.

The apparent policy of reserving the right to use these weapons first was again stated in a State Department historical office publication, research project No. 449, dated November 1960, a portion of which I shall read, which states:

The Departments of State and Defense have expressed strong opposition to a proposed congressional resolution that would have committed the United States not to use biological or chemical weapons under any circumstances unless they were first used by our enemies. The resolution has not been approved. The President thus remains free to determine American policy on the use of such weapons in any future war.

#### AMBIGUOUS U.S. POLICY TOWARD GENEVA PROTOCOL

However, our present policy, Senator, has evolved from there. I believe there has been a beneficial direction, and I would like to quote from a letter to Congressman Rosenthal of New York from William B. Macomber, Jr., Assistant Secretary of State for Congressional Relations. This is a letter of December 22, 1967. It was in answer to a letter from Congressman Rosenthal dated December 4, 1967, and an important passage in the letter from Assistant Secretary Macomber states:

We consider that the basic rule set forth in this document (i.e., the Geneva Protocol) has been so widely accepted over a long period of time that it is now considered to form a part of customary international law.

Senator CASE. What is that principle again?

Dr. MESELSON. The principle—

The CHAIRMAN. No-first-use.

Dr. MESELSON. No-first-use of chemical and biological weapons.

However, I would submit that our policy may still seem to be somewhat ambiguous. This is partly because of our previous statements saying that we did not feel bound by the Geneva Protocol, and partly because of certain more recent statements of the Defense Department. I would like to quote from a letter or rather from the testimony of former Deputy Secretary of Defense Cyrus Vance, which was presented to the Disarmament Subcommittee of this committee on February 7, 1967. In his prepared testimony Deputy Secretary Vance stated:

We have consistently continued our de facto limitations on the use of chemical and biological weapons. We have never used biological weapons. We have not used lethal gases since World War I and it is against our policy to initiate their use.

Senator AIKEN. Does that comport with Secretary Macomber's interpretation?

Dr. MESELSON. The question that occurs to me is why the State Department characterizes the protocol as customary international law, binding on all nations alike, whereas the Defense Department's prepared statement emphasizes that our policy is de facto.

Senator AIKEN. De facto?

Dr. MESELSON. Yes.

Senator CASE. There is also a difference in the subject. Mr. Vance doesn't say we haven't or wouldn't use tear gas.

Dr. MESELSON. That is right.

## TEAR GAS

I would like to say something specifically about tear gas.

Senator CASE. It does not say that we will not use tear gas?

Dr. MESELSON. No. Our present policy is that tear gas is not covered by the Geneva Protocol.

Senator AIKEN. In this case de facto means subject to change without much notice, doesn't it?

Senator CASE. That is what we are doing.

Dr. MESELSON. I think our policy on this is illuminated by the statement of Mr. Nabrit on behalf of the United States speaking before the United Nations General Assembly on December 5, 1966. Mr. Nabrit spoke as follows:

The Geneva Protocol of 1925 prohibits the use in war of asphyxiating and poisonous gas and other similar gases and liquids with equally deadly effects. It is framed to meet the horrors of poison gas warfare in the first World War and was intended to reduce suffering by prohibiting the use of poisonous gases such as mustard gas and phosgene. It does not apply to all gases. It would be unreasonable to contend that any rule of international law prohibits the use in combat against an enemy for humanitarian purposes of agents that governments around the world commonly use to control riots by their own people.

Senator CASE. That is certainly the American doctrine.

Dr. MESELSON. That is our current position, as I understand it, Senator.

However, I believe that Mr. Nabrit was in error to say categorically, that the Geneva Protocol was not framed with the question of tear gas in mind. The reason I say that is, first of all, great quantities of tear gas were produced and used in World War I. Second of all, in 1930 the Government of Great Britain addressed a question to other nations regarding the applicability of the Geneva Protocol to tear gas, and I have here a copy of the British question, a memorandum on chemical warfare presented to the Preparatory Commission for the Disarmament Conference in Geneva November 18, 1930. The British Government points out that there may be some difference of opinion as to whether the Geneva Protocol covers lacrimatory gas—that is, tear gas—and they state that—

From every point of view it is highly desirable that a uniform construction should prevail as to whether or not the use of lacrimatory gases in war is considered to be contrary to the Geneva Protocol of 1925.

The British Government states that, for its own part, it considers that tear gas is prohibited. It states:

Basing itself on this English text, the British government has taken the view that the use in war of "other" gases including lacrimatory gases was prohibited.

The CHAIRMAN. Your point is that if you use one gas it is an open invitation to use any other. As you noted a moment ago, if you used tear gas it would lead to the use of other gases.

Dr. MESELSON. That is certainly a hazard, and I think the question of tear gas might be approached in the following way. The record shows that a number of countries have stated that tear gas is covered by the Geneva Protocol. The response to this British question was that the following month the delegates of Rumania, Yugoslavia, Czechoslovakia, Spain, the U.S.S.R., France, China, Italy, Canada, Turkey

all stated that their governments considered that tear gas was forbidden under the protocol.

Senator AIKEN. Did that include Red China?

Dr. MESELSON. No, this was back in 1930.

The CHAIRMAN. But China has now ratified.

Senator AIKEN. China has ratified though, since.

#### PROS AND CONS TO USE OF TEAR GAS

Dr. MESELSON. I would like to express the opinion that the question of tear gas might be approached as follows. On the one hand, there is no question that there is a danger of escalation when any gas is used.

On the other hand, it might be felt that tear gas is a useful weapon and under some conditions might actually cause less fatalities than other means.

I would point out that one should expect any gas to be used in conjunction with other weapons, and that, therefore, even tear gas, although it is nonlethal, would, under the conditions of war, be used to enhance the effectiveness of lethal weapons. That is indeed the way it had been used in World War I. That is also the way it has been used on occasion in Vietnam.

The CHAIRMAN. In Vietnam, you mean to flush out soldiers and then shoot?

Dr. MESELSON. For example, Senator, a large quantity of tear gas was dropped in one instance before a B-52 raid. Again a large quantity of tear gas was dropped from the air before an artillery attack. These events are reported in the press. I don't have extensive information as to other ways in which tear gas is used, but a very large quantity of tear gas is being used in Vietnam.

My point is that there are pros and cons to the use of tear gas in war. The argument against it, of course, is that it could lead to a highly undesirable escalation.

#### NAPALM

The CHAIRMAN. What about napalm, how do you class napalm?

Dr. MESELSON. Napalm is not classed as a chemical weapon because it does not act by poisoning people. It acts—it is described—as an incendiary.

Senator AIKEN. What creates the flames?

Dr. MESELSON. It contains gasoline, jellied gasoline.

Senator AIKEN. I see.

#### WHITE PHOSPHOROUS CHEMICAL WEAPONS

The CHAIRMAN. What about white phosphorus?

Dr. MESELSON. White phosphorous is a chemical but again it acts by intense burning, lodging in the skin and burning so that it is not acting primarily because of a poisonous action.

The CHAIRMAN. And no one can claim it is covered by the Geneva Protocol?

Dr. MESELSON. It is definitely not, in my understanding. Flame weapons are definitely not covered.

The CHAIRMAN. By any agreement?

Dr. MESELSON. By the Geneva Protocol.

Senator CASE. And phosphorous raises the temperature. It isn't just a chemical blistering?

Dr. MESELSON. No, it is burning. It ignites spontaneously in the air and the burning continues in the body. A piece of phosphorous lodged in the skin continues to burn.

Senator AIKEN. And defoliants are not covered?

Dr. MESELSON. I am not an expert on what the status of defoliants would be in the protocol. They are not mentioned in the protocol specifically.

Senator AIKEN. I suppose nitrates?

Dr. MESELSON. I would like to say this though, Senator, about the question of nonlethal gas. Various rules can be imagined. One could have the rule that no lethal and no nonlethal gas at all could be used. One could have the rule that it is permissible to use nonlethal gas but not in order to kill, that is, not in order to facilitate the effectiveness of lethal weapons. One could have various rules.

#### UNIFORM RULE ON TEAR GAS URGED

It seems to me that the important thing is that there be a uniform rule, and that the approach of the United States might be to discuss with other nations what a uniform rule might be. Unless we consider it vital to our security interests to decide this question unilaterally, a reasonable procedure would be to consult with other nations with the objective of finding a uniform rule.

As I have stated, there is an expression on the record by a number of countries that they believe tear gas is prohibited by the Geneva Protocol.

Senator CASE. Were there any dissents to that British inquiry?

Dr. MESELSON. The U.S. representative, Ambassador Hugh Gibson, stated that this was a complicated question and that he hoped it would receive further consideration. He did not specifically say that the United States believed that tear gas was prohibited or was not prohibited. He did point out that tear gas was widely used for domestic purposes.

Subsequently, the Disarmament Convention in Geneva in the 1930's addressed this very question. It set up an advisory committee on which the United States was represented. It eventually came to the conclusion that in any future disarmament treaties the use of tear gas should be prohibited but the manufacture of tear gas could not be prohibited. This point of view was explicitly accepted by the U.S. delegate, Mr. Wilson, at that time, but the treaty, which was being worked on by that conference, never came into effect.

Senator CASE. That you have it for retaliation, was that the rationale?

Dr. MESELSON. No, the rationale was, since it was useful for police purposes at home, it would make no sense to prohibit its production.

Mr. McCARTHY. I feel this is a very important point. We included it in the material that we sent to State and Defense, and to ACDA, [deleted] and yesterday the ACDA people expressed, well, let's say they didn't know about this, and they were quite intrigued with the 1930 discussion about whether tear gas was included. We included this

discussion in the material we placed in the Congressional Record on April 1, 1969. I think it presents a rather compelling argument that the framers of the protocol intended that tear gas be included.

I might also say that we included in our material the references to the press reports of the use of tear gas in conjunction with bombing and artillery raids. The executive branch had an opportunity to dispute this and say perhaps the press reports were wrong. It didn't, and I assume from its acquiescence in this suggestion that this has been done. I don't think there is much question about it.

Dr. MESELSON. I don't think so either.

#### 18-NATION DISARMAMENT COMMITTEE DISCUSSION

I think this is a particularly opportune time to bring up this question because, as you know, the discussions at the 18-Nation Disarmament Committee to which you referred, Senator, will presumably take up this question. President Nixon has written to Ambassador Gerard Smith, our Ambassador at those talks, as follows, and I quote from a letter of March 15 from the President to Ambassador Smith:

While awaiting the United Nations Secretary General's study on the effects of chemical and biological warfare the United States delegation to the ENDC should join with other delegations in exploring any proposals or ideas that could contribute to sound and effective arms control relating to these weapons.

Premier Kosygin of the Soviet Union has also expressed his interest in discussing chemical and biological warfare arms control, and the British have in fact submitted a so-called working paper to the 18-Nation Disarmament Committee at Geneva proposing that the production of biological weapons be prohibited. That would go beyond the Geneva Protocol.

#### SOVIET UNION'S USE OF CHEMICAL WARFARE

The CHAIRMAN. In that connection, I am told that in a recent briefing made to Congress, Brigadier General Hebbeler said this: "Today the Soviet Union is better equipped, militarily and physiologically, for chemical warfare than any other nation in the world. And he also said "indications are that they"—chemical weapons—"would be used if this served the Soviet Union's purpose." What would be your comment of that? Is it true?

Dr. MESELSON. I don't have accurate knowledge of what Soviet preparations are. I would make several remarks. The first is that, if possible, one should always search for a policy which is proof against whatever other countries are doing. If there is a policy which is wise enough and general enough that it is not too dependent on what other countries could or might do in the future, that is obviously the best policy.

I think that the policy of no-first-use has this attribute. The policy of ratifying the Geneva Protocol, for example, making it clear to all that we would never use these weapons first, is relatively independent of what other countries are doing.

With regard to research and development programs, stockpiling and so on, I think what other countries are doing becomes more relevant, although even here to a very great extent in the strategic area chemical and biological weapons have been eclipsed by nuclear

ones. Except with regard to what small nations which do not have nuclear weapons may be doing, I think that far more important is what the Soviet Union does in the nuclear field.

#### EXTENT OF U.S. CBW EFFORT

The CHAIRMAN. Well, in this connection, do you know about the extent of the effort of the United States in chemical and biological warfare?

Dr. MESELSON. Yes, I have a rough idea.

The CHAIRMAN. How would you characterize it? Is it great and for how long has it been going on?

Dr. MESELSON. Well, to some extent it has been going on since World War I, of course. The current budget for chemical, biological warfare research and development I understand is in the vicinity of \$400 million a year.

The CHAIRMAN. Has it been at about that level for the last several years?

Dr. MESELSON. No, at the close of the Korean War it was much less, I think about \$10 million a year. It rose particularly in the late 1950's and then it continued to rise to its present level. It was because of that rather steep rise in the late fifties. I understand, that Congressman Kastenmeier introduced his joint House-Senate resolution.

The CHAIRMAN. I notice General Hebbeler didn't mention biological weapons. Do you think that was on purpose or simply through inadvertence?

Dr. MESELSON. I really don't know, Senator. In discussing the capabilities of the Soviet Union, I think one must go beyond asking simply how much they have, but ask what would really happen in any given contingency, in any given war if one confronted an enemy with these weapons.

What I have in mind is, for example, in Europe, it might be desirable to maintain a limited war fighting capability with nerve gas for use in Europe. However, it is hard to imagine a protracted nerve gas conflict in Europe. What I am saying is that beyond a certain amount, beyond the amount necessary simply to let the other side know that to start this kind of war would be—wouldn't cause anything but trouble to both sides—

#### CBW WEAPONS AS SECOND STRIKE WEAPONS

The CHAIRMAN. I want to come back to this. Earlier we talked about this as a first strike weapon and you demolished the idea that it is useful because of the time element, that is, it takes too long.

Dr. MESELSON. That is biological weapons.

The CHAIRMAN. Biological weapons. And chemical weapons more or less because they take more time compared to nuclear. But I didn't pursue this idea of their potential use as a second strike weapon, that is as a retaliatory capacity. It seems to me that if we are attacked, if an attempt is made to strike us and we are attacked first, this would still remain a very effective second strike weapon, and, in that sense, it is a deterrent. The theory of our nuclear strategy is that we are going to have a second strike so devastating that the enemy will not launch a

first strike. That is the theory, isn't it; the so-called balance of Terror?

The existence, it seems to me, of a substantial capacity to inflict chemical and biological—we have never said anything about radiological, you might say a word about that before we are through—damage would add greatly to our deterrent, wouldn't it?

Dr. MESELSON. I don't think it would add anything useful, Senator.

The CHAIRMAN. Why not?

Dr. MESELSON. I think that nuclear weapons are a far better deterrent because they are predictable. I think that—

The CHAIRMAN. Wait a minute, let's assume you had these weapons and they are deliverable. You see, the Secretary of Defense is saying the Russians are going to have a capacity to knock out all Minutemen missiles. They are going to fire the SS-9's at all the Minutemen, leaving us with none. He doesn't say anything about the Polaris, but wouldn't the existence of a weapon of that seriousness add anything to our second strike capacity, assuming that our nuclear force is incapacitated? I don't assume it, but this is a hypothetical I am asking.

Dr. MESELSON. I think if there were no nuclear weapons in the world, that chemical and biological weapons might be considered as strategic deterrents. It is my strong opinion that there is not only no need but there is really no room for chemical and biological weapons as strategic deterrents because I think they would make the situation more hazardous, more dangerous. There are a number of reasons why I think that.

#### EXTENT OF U.S. CBW STOCKPILE

The CHAIRMAN. You have already stated, but I don't believe you have done so on the record, your estimate of what stockpiles we presently have. You have an estimate, don't you? Are they substantial?

Dr. MESELSON. I don't have at my immediate command the exact size of the stockpiles. I try to forget these numbers.

The CHAIRMAN. I didn't ask you the exact size, only the approximate size. Is it substantial?

In my State there is a very secret—at least to me—very large ordnance at Pine Bluff, Ark. I have been told it makes both kinds of weapons. When you fly over it you can see one after another of these storage depots. Can't you give us some idea of the magnitude of our stockpile? If it is classified say so, and we can strike it from the record. I want to know if it is substantial.

Dr. MESELSON. [Deleted.]

Mr. McCARTHY. Senator, I wonder if I could interject here. This numbers game, and I am sure Professor Meselson would agree, when you get into estimating the lethal doses and so forth, you are getting into a real numbers game. As the professor points out, it depends.

Now, Major General Rothschild, who at one time headed this program, wrote an article for Harper's magazine that appeared—and I have it at the office—either in 1959 or 1960, in which he stated that 6 ounces of a substance that produces Q fever would be enough to kill 28 billion people. That is a quote from General Rothschild.

Are you familiar with that, Professor?

Dr. MESELSON. I am not familiar with that quotation.

Mr. McCARTHY. It is kind of a maddening estimate.

## U.S. SHOULD NOT STOCKPILE BIOLOGICAL WEAPONS

**Dr. MESELSON.** There are a lot of scary things that one can say about biological weapons. My view is that they are nevertheless ridiculous weapons, that we should not concentrate on the scary studies of how if you spoon-feed a certain amount to every person on this planet you can kill them. What we should think about are the realistic military requirements of actual nations and whether these weapons make any sense.

I myself do not see any sense for the United States in stockpiling biological weapons. I think we would do ourselves far more harm than good by stimulating interest in these weapons, by breaking down the barriers against them. I think we are adequately safeguarded, insofar as deterrence is functional at all, by nuclear weapons which are reliable.

**The CHAIRMAN.** You see, the Secretary of Defense was raising great fears about this. That is why we are asking about it.

**Dr. MESELSON.** But I do not think our country would want—

**The CHAIRMAN.** I do not think we are.

**Dr. MESELSON (continuing).** Would want to rely on a totally unpredictable weapon. It is not the kind of weapon that a large power should consider for strategic use. However, I might add that once a country advertises that it is prepared to use biological weapons as strategic weapons, it has in effect announced a program of antipopulation warfare. This is to throw away all chance of a damage-limiting understanding if war gets started. It seems to me that this would be an extremely foolish thing to do.

## DETERRENT CAPABILITY OF CHEMICAL WEAPONS

**The CHAIRMAN.** What you are saying relates only to biological weapons. Does it relate to chemical weapons as well?

**Dr. MESELSON.** Since it would require far more of chemical weapons than of nuclear weapons, and since chemical weapons also cannot prevent enemy missiles from being launched against us, it also applies to chemical weapons.

Only poor countries or underdeveloped countries, countries that do not have nuclear weapons, it seems to me, could possibly see any attraction in chemical or biological weapons as strategic deterrents.

**The CHAIRMAN.** Let us assume we are vulnerable and that the Russians are going to outdo us and can destroy our nuclear capability, then you still say they have no utility.

**Dr. MESELSON.** If you put to me the question if I were advising the Government, and it seemed clear we had absolutely no other deterrents and we were faced by a determined enemy, should we then develop biological weapons as a deterrent? I would answer, "Yes."

**The CHAIRMAN.** In other words, if Secretary Laird is correct, and we are threatened with their overpowering us and being capable of taking out our nuclear deterrent, then you would say, "Yes."

**Dr. MESELSON.** I would. But I think in this matter, as I said before, that to consider weapon-by-weapon cases or situation-by-situation matters is not a good way to arrive at a policy.

The CHAIRMAN. Professor, I think the whole thing is utterly irrational. What I am trying to do is to elicit information to try to meet irrational arguments. I think what the administration spokesmen have been saying in this ABM debate is irrational. But if you are dealing with this kind of a situation, then you have to do the best you can with what the facts are. I do not want you to say anything you do not believe.

Dr. MESELSON. I would like to outline what I think a good policy would be for the United States in this area.

#### SOVIET CHEMICAL AND BIOLOGICAL WEAPONS

The CHAIRMAN. Before you do, do you know anything about Soviet stockpiles of chemical or biological weapons?

Dr. MESELSON. I spent one day at the Central Intelligence Agency quite a while ago trying to familiarize myself with Soviet capabilities.

The CHAIRMAN. Yes.

Dr. MESELSON. One must bear in mind two things regarding intelligence estimates. One is the difference between possible, probable, and confirmed capability. If one receives, for example, an estimate that the Soviets have so many pounds of nerve gas, one must know whether this is a possible number of pounds, a probable number of pounds, or a confirmed number of pounds. This is very important.

The second thing is that in the intelligence community, of course, there are priorities. There are certain things we must obviously know with higher priority than others. It is relevant then to ask with what priority, how much effort has been put into finding out these things. Generally speaking, this is a relatively cheap kind of work to do. The Soviet Union is a big country. They have excellent chemists and biologists just as we do. They have, therefore, the possibility of going as far as we can.

[Deleted.]

#### U.S. RATIFICATION OF PROTOCOL URGED

Dr. MESELSON. It seems to me that the main questions before the United States now as these negotiations get underway are, do we want to ratify the protocol and what additional agreements do we want? One can have the largest or the smallest CB establishment you like. The protocol merely would prohibit first use. It seems to me that it is confusing to ask in detail what is being done or what might be done by various countries when considering the question of a no-first-use pledge. I think this is an important point.

Senator CASE. I think you are absolutely right about this, but do you not think under the present circumstances of our domestic troubles—riots on the campuses, cities, too, increased concern about the handling of mobs of people—that it would be very difficult to persuade the American people that the use of tear gas, which is disabling temporarily, is not only highly desirable but indeed humane. To many Americans, it might be a darned good idea for a relatively small country as we are compared to others in manpower to maintain such a stockpile. I wonder, in other words, if we are not going to sell something—

The CHAIRMAN. On a first strike policy.

Senator CASE. What are you going to say about a United Nations force trying to deal with passionate people to whom rationality does not exist, people who are drugged, people like the Japanese kamikaze pilots? Does this apply where you have no nuclear weapons at all? This is not a matter of national policy. We have not said it. We have not disabled ourselves in nuclear weapons as against vastly greater numbers in Europe of Soviet troops and Warsaw Pact troops invading Western Europe, but nevertheless I think most of us are moving in this direction.

Is it wise to attempt at this time to draw an issue on the basis of no gas at all?

#### BARRIERS AGAINST USE OF WEAPONS SHOULD NOT FALL

Dr. MESELSON. That is certainly an important subject for discussion. I would suggest the following framework for arriving at an answer. I think it is clear that it would not serve the interests of the United States if 10 or 20 years from now we faced a world in which the barriers against the use of chemical and biological weapons were gone and they were regarded as ordinary weapons. At all levels of hostility, I believe this would create a world in which, although the United States could perhaps outmatch all other countries, we would still be much worse off.

At the strategic level, it would mean that countries which do not now possess the ability to cause great devastation would possess it if those barriers and restraints were gone.

At lower levels, even in guerrilla wars, it seems to me, that our position would be greatly worse than it is today if the barriers against poison gas were dropped for this reason: poison gas is a lightweight weapon, with a capability of covering a large area. [Deleted.]

If lightweight mortar shells containing nerve gas, for example, were available to guerrilla forces who knew where government forces are located, this would serve them far better than would such weapons in the hands of government forces, because they know where the government forces are and the reverse is less often the case.

The CHAIRMAN. Why do you suppose they have not used them?

Dr. MESELSON. I believe they have not used them because the rules of the game have not gotten to that point. I believe if we were ever to use nerve gas in Vietnam, as has been suggested recently in a book by a U.S. military officer—although he suggested a limited use of it—I do not believe we could expect the enemy to play by the rules we set down.

Nevertheless, let me suggest that if nerve gas ever comes into use as napalm, artillery or other things, this would place in the hands of small forces a destructive capability vastly greater than anything they have now. This would also compel the opposing forces to wear very cumbersome masks and protective suits.

Government forces wearing masks and protective suits would not look very friendly to civilians. Gas would impede movement. It would greatly complicate war.

Furthermore, it would enable guerrillas to have the ability, with a few lethal gas shells launched against a city, to create a situation in which every man and woman in the city demands protection against those weapons.

I do not think the United States or any power would like to see a situation in which small forces can cause that degree of violence and that degree of havoc.

I believe that if we try to visualize what the world would be like if there were no special distinctions about chemical and biological weapons, that it would be a world in which the security of this country and all countries would be vastly reduced.

#### TEAR GAS AS A STEP IN BREAKING DOWN BARRIERS

Let me return to the question of tear gas. I think it is wrong to look at the question of tear gas in isolation.

If one places emphasis on avoiding a world in which chemical and biological weapons are legitimized, displayed, proliferated, and even used, then one must consider tear gas in the context of a step toward breaking down the barriers.

Now, this is not a question, it seems to me, that can be decided unilaterally. If you are talking about rules of warfare, you have got to talk about what is the practice and custom of other nations. If we were just creating the Geneva Protocol, it would be relevant to ask all the other countries what they wanted to do about tear gas. But we are not just creating it. Although we have not ratified it, over 60 other nations have. We are not talking about a dead treaty. It is the oldest major arms control agreement now in force. It is a live treaty even though it is old.

Therefore, we should approach this question of tear gas I think, as follows: It is not by itself a moral issue; but it is a very important technical issue. Can we find rules under which tear gas can be used that will be respected by most countries or all countries, and, therefore, use it without fear of escalation, or can we not? If we cannot find rules that give us some assurance that the whole spectrum of chemical and biological weapons will not come into use, then I think we should not use tear gas in war. After all, tear gas is only of trifling importance to our national security. The security of the United States in no way hinges upon our ability to use tear gas. [Deleted.]

It may not be possible to find a clear and workable rule that would distinguish non-lethal gas from lethal gas and that would be acceptable to other nations. Experience has shown that when tear gas was used in the First World War or the—

The CHAIRMAN. Is that CN?

Dr. MESSERSON. CN is a tear gas developed after World War I. But other tear gases were used in that war and they were used in close conjunction with lethal weapons. This means that the distinction between lethal and nonlethal is robbed of a great deal of its meaning. You must ask the question therefore, How can an essentially meaningless distinction be maintained? I submit that it would be difficult. That was the reason why many nations have held that tear gas was prohibited by the protocol.

One might still, however, create a rule under which tear gas could be used in war but not in order to kill. One could try that way. If the important nations in the world said, "Yes, we see the validity and the reason for doing this, we will modify our position on the Geneva Protocol," we could all then say it is not a moral question, it

is a technical question, we think we have reached a satisfactory approach to it. From now on the tear gas chloracetophenone, used not in order to kill, is all right. But I consider that this would still be risky and also difficult to achieve. Furthermore when you have whittled it down that far, it makes so little difference that one must ask if it is really worth trying to open up the whole question of the protocol which has been ratified by so many countries. Is it really worth causing all that trouble and all that risk for the future?

#### CONSULTATION WITH OTHER NATIONS URGED

I think the way to approach it is to consult with other nations open mindedly on this issue.

There was a time when even the United States felt that tear gas should be prohibited. There was a time when the leaders of the armed forces believed that. Our views have changed back and forth. I submit this is a question that can be studied in rational form but that the important thing is to get a uniform and workable standard. That is important.

#### DIFFERENCE IN DOMESTIC AND FOREIGN USE OF TEAR GAS

Mr. McCARRY. Senator, I wonder if I could just say this: it seems to me that the use of tear gas against another nation's forces is one thing, and the use against your own domestic population is another.

Dr. MESELSON. Absolutely.

The CHAIRMAN. The question is, in using it against another nation, the danger of retaliation and escalation comes up, assuming they have the capability? Your own domestic population just does not have it.

Senator CASE. This sort of gets around to a couple of things, though. It suggests, as you say, that we should not use scare tactics, talk about the horrible nature of a can of anthrax, which would kill everybody and how awful these things are, and yet this is a pretty tricky business as far as handling public opinion goes. When everybody is conditioned to think about this whole matter as a moral question, is it better to treat your own population brutally than it is to treat others that way? And so it is a pretty tricky business. [Deleted.]

Some of the things you have said suggest it would be a lot better to have this in reserve as a retaliatory weapon than it would be to build up our nuclear arms.

The CHAIRMAN. It seems to me the existence of it would certainly—

Senator CASE. But you cannot fool around with that idea and follow Dr. Meselson's general idea of this being—

Mr. MESELSON. Mr. Chairman, I am not saying we should not do research and development or even that we should not stockpile certain weapons.

The CHAIRMAN. The whole theory is you use it only for retaliation, in conformance with the protocol.

Senator CASE. It has to be ready in weapons form.

Dr. MESELSON. The important thing is to look at it through the lens of preventing the use of these weapons, and it may be that through that lens you need to prepare certain retaliatory forces.

## STORING STOCKPILED CB WEAPONS

The CHAIRMAN. May I ask, how long will these things stay alive? After all, they are organisms, and you say they are stockpiled. Do they last very long?

Dr. MESELSON. It depends on the type, Senator. In dry form, spores, for instance, can be stored for years.

The CHAIRMAN. Oh, they can.

Dr. MESELSON. Bacteria—

Senator CASE. Like dry and wet yeast.

Dr. MESELSON. In dry form they can be stored for a longer time, but in wet form they can be stored for only a matter of hours.

The CHAIRMAN. Take a thing like anthrax which is considered the most deadly. In dry form, could it be stored for quite a while?

Dr. MESELSON. Yes, you may have read in the papers that there is an island off Scotland, Gruinard, which was the site of a test of anthrax. It is still off limits, and it would be dangerous.

The CHAIRMAN. Could that be the source of anthrax that has plagued Britain so much? You know they had to kill, I believe, 50,000 animals last year.

Dr. MESELSON. Was that not hoof and mouth disease?

The CHAIRMAN. Is that not anthrax?

Dr. MESELSON. No.

The CHAIRMAN. I thought it was. It is similar, is it not? I thought it was similar. I do not know.

Dr. MESELSON. It is similar in that it is a threat to animal stocks, but it is biologically quite a different thing.

## HAZARDS OF STOCKPILES

The CHAIRMAN. How much of a hazard to us is the existence of these large stockpiles? I understand they are shipped about occasionally on railroad cars. Supposing one of them suffers an accident and is disrupted, what is the situation?

Dr. MESELSON. I do not know if biological weapons are shipped on railway cars. Nerve gas is shipped on railway cars. An accident could be very serious.

The CHAIRMAN. Could be serious?

Dr. MESELSON. Yes, it certainly could.

The CHAIRMAN. How do they ship biological weapons, by automobiles?

Dr. MESELSON. I am not familiar with whether or not biological weapons are shipped and, if so, how.

The CHAIRMAN. You mean all that are made in the Pine Bluff Arsenal stay there?

Dr. MESELSON. I do not know. Field Manual 3-10, the earlier one, states that refrigerated vans are available to transport biological weapons to the field. Whether or not there is any transportation of such weapons actually going on—

The CHAIRMAN. What do you know about that, Congressman?

Mr. MCCARTHY. Yes, we have a document from Fort Detrick which lays out the procedures by which biologicals can be shipped in commercial airfreight, in commercial canisters of up to 1 gallon, and it gives locations where it can be shipped by air in a cargo plane, not in a passenger plane.

The CHAIRMAN. How do they get it to the airport, by truck?

Mr. McCARTHY. Well, I am sorry, I do not recall that particular part. I can get that document and send it over.

The CHAIRMAN. Would you say it is a substantial hazard, the existence of these stockpiles?

Dr. MESELSON. I would say it is definitely a substantial hazard. We live in a world which is full of substantial hazards.

The CHAIRMAN. Yes.

Dr. MESELSON. Another hazard would be if chemical or biological weapons came into wide use and, as a result, a few maniacs—in a population of 4 billion there are going to be some maniacs—decided they would spray it in a city. That is a very serious hazard if these weapons become commonplace. Today they are not commonplace.

One, of course, should maintain reasonable safety standards, but it seems to me the thing we must keep our eye on is what kind of situation do we want 5, 10, 15, 20 years from now. Do we want a world in which these are accepted or not?

#### RADIOLOGICAL WARFARE

The CHAIRMAN. It is getting late. I wonder if it is appropriate to ask you if you know anything about what is referred to as radiological warfare? What does it mean?

Dr. MESELSON. It means the production of radioactive materials for distribution over a target. It would act by irradiating humans. It would cause death due to radiation sickness. This kind of warfare has largely been rejected because it is impractical. It turns out that to produce enough radioactive material to have a significant military effect is an enormous undertaking, whereas the explosion of a nuclear weapon, which also generates radioactivity, is by contrast a relatively simple undertaking.

The CHAIRMAN. The most efficient way to do it.

Dr. MESELSON. Yes. [Deleted.]

#### CONGRESSIONAL SCRUTINY OF CB WARFARE

Senator CASE. You recall Senator Clark's amendment last year, that was accepted by the Senate, to require a report on CBW activities annually to Congress. I understand you are not very hot about this as a useful thing. I was thinking about offering it again this year. Why would it not be helpful to get this information out?

Dr. MESELSON. I do think it is important to subject these programs to congressional scrutiny. But my point, I think you are referring to, is this: military programs are, after all, enormously complicated and detailed and one cannot expect any part of our civilian government to maintain full scrutiny of all of these at all times. There just simply is not enough available technical manpower for that task.

On top of that, if you have an effect during one year of stopping an unwise program from going forward, there is always the next year and the next year.

#### CONSIDERATION OF U.S. RATIFICATION OF GENEVA PROTOCOL URGED

A more effective approach would be to consider the merits of the United States ratifying the Geneva Protocol. Then I think that the

situation would be changed. This is a country which very much respects its treaty obligations.

If we are not bound by the Geneva Protocol, proposals will be made at low levels up to higher levels, for using a particular chemical or biological weapon. That flow of proposals would stop if it was the declared treaty policy of the United States never to start this. It does not mean we would not have the capability, the potential, of doing it in retaliation, but it does mean you would not have to worry about a day on which the President of the United States, faced with a crisis, found on his desk a proposal to use, let us say, a biological weapon, having never had the time to give this deep consideration, but being told by advisers that this would be a good thing to do. In such a case he might authorize it. He would not be protected by a previous treaty commitment.

If you come to the decision that you want to keep out of this business unless somebody pushes us into it, you should implement that decision in the form of a treaty obligation that is lasting.

We have seen that President Roosevelt had one policy, and that other administrations seemed to have different policies subsequently. Now we seem to have returned to the no-first-use policy, at least for poison gas and lethal germs. The policy of a President is not as binding as a treaty.

The CHAIRMAN. Do I understand you to say, in answer to his question, that you have no objection to the Clark amendment, but that you think adherence to the protocol is more important. Is that what you said?

Dr. MESELSON. Yes.

Senator CASE. One does not exclude the other.

Dr. MESELSON. Absolutely not. Public scrutiny is needed.

Senator CASE. That was the purpose of it.

#### RELEASING STATEMENT

The CHAIRMAN. Do you see any reason why we should not have a public discussion? Do you see any reason why I should not give your statement to the press?

Mr. MESELSON. My prepared statement?

The CHAIRMAN. Yes.

Dr. MESELSON. No reason whatsoever.

The CHAIRMAN. Later we will deal with your testimony.

Your comments that you considered classified and so stated, you will have an opportunity before the hearing is released to go over them and delete those parts that are classified.

Since this statement is prepared for delivery, we can give it out.

Senator CASE. The chart and everything else.

#### FOREIGN MILITARY OFFICERS INSPECTION OF CB WEAPONS

The CHAIRMAN. Do you know whether any foreigners who come here—we have a great many thousands of military officers who come here—do you know whether they have been instructed in, or are allowed to inspect, our facilities in the field of chemical and biological weapons?

Dr. MESELSON. Yes.

The CHAIRMAN. They are?

[Deleted.]

The CHAIRMAN. Are Spanish visitors allowed to visit?

Dr. MESELSON. I do not know about the Spanish.

[Deleted.]

#### YEMEN'S GAS WARFARE CAPACITY

The CHAIRMAN. Where did the Yemen get its gas warfare capacity?

Dr. MESELSON. I have looked into this matter. [Deleted.] They are very primitive bombs. They were constructed from ordinary high explosive bombs by milling at the bottom a thread so that one could attach a ring. On the ring were attached hand grenades containing gas, and then more such rings were added with more hand grenades. This is a Rube Goldberg bomb.

[Deleted.]

My impression is that this was a rather primitive effort. Toward the end it was believed that the Egyptians had used a nerve gas, and it was stated that there were cyrillic characters on some bomb casing.

Of course, it is well known that the Egyptians do get their bombs from the Soviet Union. In fact, so do the Yemeni Royalists whom they were fighting. [Deleted.] They are both supplied from Eastern bloc nations. [Deleted.] The Yemeni Royalists bought some of theirs from Bulgaria. So all of them may have cyrillic characters.

I know of no evidence that this was Russian gas. All the evidence I know of was that it was a rather primitive attempt, but it does apparently show that even a country like Egypt is capable of producing and using gas.

I also noticed in the Swedish newspapers that Egypt was now supplying gas masks to its forces.

Senator CASE. What was the kind of gas?

Dr. MESELSON. In the Yemen, they began with tear gas. They then used mustard gas, and phosgene, and the latest gas they used in January of 1967 may have been a type of nerve gas.

I asked a British chemist who had spent some time in Cairo whether he thought that his Egyptian chemist colleagues could have produced nerve gas in Egypt, and he said without doubt yes.

The CHAIRMAN. Any further questions?

#### DEFENSE AGAINST BIOLOGICAL AGENTS

Senator CASE. Just one more question. Have you any comment on what is going on in the way of defense against these agents?

The CHAIRMAN. Antidotes.

Senator CASE. Antidotes, and the medical things you do with people who are smitten with it?

Dr. MESELSON. Well, to speak about biological weapons, it is my opinion that in terms of present knowledge and technology it is hopeless to try to develop a defense against each possible biological agent. Antisera and drugs may be useful against one agent or against another, but there is no antiserum, no drug, which is useful against all. After all, we cannot cure virus diseases; the common cold has no remedy. Nearly all virus diseases have no remedy at all.

The only realistic defense against biological weapons is a mechanical barrier that prevents the particles of the biological agent from reaching human beings. That is a gas mask or an air conditioned shelter. That is quite an effective defense. In any case, of course, one needs adequate warning.

One can defend against these weapons, but it is an enormous undertaking. You would have to train people in civilian defense so that they could get into shelters quickly and supply them with very good gas masks, make sure the men are always clean shaven so that the gas mask will adhere to the face well. You would have to have an early warning system. It would be a monumental effort.

I think what one should have are contingency plans so that at some future time if it really looks as if there is a threat one can expand those contingency plans. [Deleted.]

The CHAIRMAN. You used one term I do not think you defined. I think it was rickettsia or something. I do not find that. Did you not use it? What does it mean?

Dr. MESELSON. Ricketts are like a bacteria, but they are not able to live on their own. They are parasitic bacteria, so to speak.

The CHAIRMAN. That is about all I can think of at the moment. I have learned a great deal.

#### SCIENTIFIC OPINION ABOUT CB WARFARE

Senator CASE. A general question the staff has suggested, and I wonder whether you might have some comment upon it. What is the general attitude among your academic colleagues about this matter?

Dr. MESELSON. I hesitate to represent the opinion of other persons.

Senator CASE. I know that.

Dr. MESELSON. I would rather speak only about my colleagues who have studied the matter. This whole question of chemical and biological warfare has so many parts, and some of them are so distracting to the imagination, that unless one has time, I would say literally months, to sit down to inquire into the characteristics of these weapons, he might come up with an opinion that might well change with longer study. So I will speak only about two of my colleagues who have been intimately connected with these matters.

They think these are poor weapons for the United States—that they can do us more harm than good, but that we should do a prudent amount of research and development aimed, however, at preventing these weapons from coming into use and that we should make this very clear by ratifying the Geneva Protocol.

Senator CASE. I was thinking of this more with respect to its importance to the job of dealing with public opinion broadly. I would guess that most academic people like most other people have not thought a lot about it.

Dr. MESELSON. I think that is right.

Senator CASE. Is that not about the size of it?

Dr. MESELSON. I think that is right.

Senator CASE. And maybe the question does not help very much.

## BIOLOGICAL WEAPONS AS SECOND STRIKE CAPABILITY

The CHAIRMAN. Assume that the President and the Secretary of Defense are right and that in the midseventies the Russians will have the capability of taking out our nuclear retaliatory capacity. Is this simply a further insurance that they will not destroy our second strike capability. Is this wrong or not?

Dr. MESELSON. I am not a nuclear expert. It goes against everything I understand about our national defense to assume that there could ever be a time when we would be defenseless except for chemical and biological weapons.

The CHAIRMAN. I do not make that assumption, you understand, but it is being made in public statements.

Dr. MESELSON. Let me say this: That if we did have some nuclear retaliatory forces, then I believe that the intrusion of biological weapons considerations in a time of crisis would be a terrible threat to our security.

If I were advising the President of the United States, and we were in a terrible crisis with an enemy and we had nuclear weapons, as we will if such crises ever come, I would advise him to take all the papers on his desk concerning biological weapons and throw them away. Biological warfare would introduce so many complicated considerations, there is so much uncertainty in it, the risks are so high. A biological warfare threat would say to the other side, in effect, "All right, we have abandoned all hope, we are going to wipe each other out, let us get started." It would take the President's mind off the very careful decisions he must make about nuclear weapons that really do work and really must not be used, if at all possible.

The CHAIRMAN. The last three Minutemen did not work; do not forget that we had three tests and all three of them failed.

Dr. MESELSON. Believe me, biological weapons are much less reliable.

The CHAIRMAN. What about chemical weapons; would you say the same thing about them?

Dr. MESELSON. I would say in time of crises that all considerations of chemical-biological warfare should be swept off the President's desk and the situation reduced to essentials.

## CAREFUL CB WEAPON RESEARCH AND DEVELOPMENT URGED

The CHAIRMAN. You believe that, beyond a very limited research and development study of these weapons for purposes of retaliation, which is authorized by the Geneva Protocol, you do not think we should put emphasis on the development of biological or chemical weapons, is that right?

Dr. MESELSON. Not quite. Whether or not we place emphasis on any particular CB weapon should be evaluated in terms of our overall determination to keep these weapons from being used. If it requires a certain capability to prevent some other country from using them, then I say let us have that degree of capability. But let us not have the kind of—

The CHAIRMAN. A deterrent capability.

Dr. MESELSON. Yes. But let us not have the kind of research-development production that places these weapons in the hands of others or inspire their use by others.

Senator CASE. Where does retaliation allow us—

The CHAIRMAN. The Geneva Protocol, as I understand it, does not prohibit our having such weapons for, well, call it a second strike or retaliatory purpose. It simply makes everyone who agrees to the protocol not to use it first. That is all it does.

Dr. MESELSON. That is all it does. The British are now proposing that with regard to biological weapons, we go well beyond that and prohibit the use of biological weapons under any circumstances.

The CHAIRMAN. That is a further step.

Dr. MESELSON. And their rationale is that biological weapons are not needed for national security, that they represent instead a Pandora's box that under no circumstances would be helpful.

The CHAIRMAN. And the Geneva Protocol relates to both chemical and biological?

Dr. MESELSON. Yes, sir.

The CHAIRMAN. I think we had better let you go. It is 1 o'clock.

I cannot tell you how much we appreciate the trouble to which you have gone to give us this information. I know it must be very trying to deal with people who know nothing about the subject.

Senator CASE. If you have to do it once a year, I think it is worthwhile.

Dr. MESELSON. I am deeply honored and grateful to be of any help in these matters.

The CHAIRMAN. I hope we make good use of it. I am not through with the subject yet. You have said many surprising things, the main thing being your estimate that these weapons are really sort of impractical. They are scare weapons but not really practical. The suggestion I made a moment ago was only because of what I think is a wholly irrational and unjustifiable tactic that the Secretary of Defense is using at the moment of trying to scare us into the ABM. That is why I mentioned it.

Thank you very much Dr. Meselson.

(Whereupon, at 1 p.m., the committee was recessed, to reconvene subject to the call of the Chair.)

