5. The Question of Offensive/Defensive Distinctions in Biological Weapons Related Research, and the Potential Stimulus to BW Proliferation by Expanded Research Programs

The word "research," or any specific reference to "offensive" or "defensive" in a research context, does not appear in Article I of the Biological Weapons Convention. That reads as follows:

> "Each State Party to the Convention undertakes never in any circumstances to develop, produce, stockpile or otherwise acquire or retain:
>
> (1) Microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes;
>
> (2) Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict."[1]

However, the word research did appear in the provisional treaty draft that had been drawn up by the U.K. and that had been presented to the negotiating states on July 10, 1969. That draft required states signing or ratifying the treaty "not to conduct, assist or permit research aimed at production..." of the agents or weapons forbidden by Article I (1) and (2) above. [2] Even earlier in a working paper on microbiological warfare that the U.K. submitted to the states negotiating in Geneva, the U.K. stated:

> 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.[3]

The word "research" was, however, omitted by the United States and Soviet diplomats who drafted the text of the treaty that was eventually accepted. The key terms at issue then become "...prophylactic, protective or other peaceful purposes," and "for hostile purposes."

While at the Stockholm International Peace Research Institute (SIPRI) in 1970, I

prepared a study that examined the question of whether there were characteristics that could distinguish between military and civilian research and between offensive and defensive research in areas that related to biological weapons. The study was part of the work for the set of SIPRI volumes on *The Problem of Chemical and Biological Warfare*, and was presented as a background paper for the Tenth International Microbiology Congress of the International Association of Microbiological Societies in Mexico City in August 1970.[4] Having had some laboratory research experience, I came to the conclusion that it was perhaps possible to draw such distinctions, but that one's conclusions were in large part guided by a knowledge or suspicion of the overall nature of the national program in which an individual piece of research was embedded. I referred to this as "the intent" of the national program in question, a phrase that has subsequently been commonly used in many other discussions of the same problem. The circular nature of that conclusion significantly undercut its value.

In 1992, the introduction to a New York Academy of Sciences volume, *The Microbiologist and Biological Defense Research: Ethics, Politics and International Security*, stated:

> Perhaps most crucial for any biological defense research project is clear demonstration of its defensive intent; this is vital since an outsider may find it difficult to differentiate between research and development (R&D) undertaken for defensive and offensive purposes... The distinction between research and development is critical to interpreting the provisions of the BWC because the treaty does not specifically mention research, offensive or defensive, but does proscribe offensive development while permitting development for peaceful purposes... The general criterion for distinguishing between offensive and defensive research is *intent,* which at best is a problematic issue... Is biological defense research sufficiently "transparent" that an outsider can readily ascertain its defensive intent?[5]

And a year later, the American Society of Microbiology, in its statement on "Scientific Principles to Guide Biological Weapons Verification," although using "development" and "research" interchangeably, reiterated the same theme: "The ASM has indicated that verifying offensive biological weapons development activities is very difficult because of the potential dual nature of research in the biosciences. Effective verification rests with determining intent of ongoing activities in R&D."[6] When an international law specialist,

Richard Falk, noted in 1984, that offensive and defensive research were distinguished only by intent, and not by substance, and that this both invited and concealed abuse, Tom Dashiell, a former Fort Detrick Special Projects Officer, then serving in the Department of Defense administering the buildup of the US biodefense program during the Reagan Administration (which is discussed below), responded that a better definition of defensive biological research "would be extremely difficult – if not impossible – to develop."[7]

If one also, on careful examination, concluded that any piece of basic research could have major "offensive" implications (as, for example, in the recent mouse pox study[8]), one was left with the argument that the only distinguishing characteristics of a BW program occurred at the point at which weapon development began. But many have even argued – and acted on – the claim that some degree of weapon development was permissible within a defensive program, as in the case of one of the recent disclosures in the United States. That pushes one even farther away from research, and leaves the only definitive determinants as production, quantities and weapons.

A useful way to sharpen this issue is to quote from two contrasting US government policy statements. A very brief US Department of Defense press statement on January 8, 2002 on Nuclear, Biological and Chemical Warfare Defense answered the question, "Is the US still developing biological weapons to use against our enemies?" The answer provided began: "As required by executive order, the US government ceased all offensive biological research in November 1969..."[9] However, the original 1969 US policy decision is worded rather differently. The operative paragraph of National Security Decision Memorandum 35 of November 25, 1969, reads as follows:

> The United States bacteriological/biological programs will be confined to research and development for defensive purposes (immunization, safety measures, et cetera). This does not preclude research into the offensive aspects of bacteriological/biological agents necessary to determine what defensive measures are required.[10]

The analytical study which supported the US policy decision also included a very important relevant paragraph. In response to the question "Should the US maintain only

an RDT&E program," it replied

> There are really two sub-issues here: (1) should the US restrict its program to RDT&E for defensive purposes only or (2) should the US conduct both offensive and defensive RDT&E? While it is agreed that even RDT&E for defensive purposes only would require some offensive R&D, it is also agreed that there is a distinction between the two issues. A defensive purposes only R&D program would emphasize basic and exploratory research on all aspects of BW, warning devices, medical treatment and prophylaxis. RDT&E for offensive purposes would emphasize work on mass production and weaponization and would include standardization of new weapons and agents.[11]

An excellent Ph.D. thesis which examined US government policy process in 1969-1972 that resulted in the joint decisions to renounce and dismantle the US offensive BW program, negotiate the BWC, and ratify the Geneva Protocol, was only able to add a single footnote by way of further amplification.

> There is much debate over what constitutes offensive and defensive research and development in the field of biological weapons. The development of munitions filled with biological agents, delivery vehicles for these munitions, open air field testing of live biological agents, enhancement of the pathogenicity of organisms, and development of production and storage techniques for biological agents constitute offensive program activities which cannot be easily justified under a defensive research program.[12]

The US policy statement in NSDM 35 cut away the problem – for the US – of whether a piece of *research* is "defensive" or "offensive": "offensive" "research" is permitted. On what basis then does the United States government make the assessment that another nation's BW program is offensive or defensive? In its research phase? On evidence of "development"? If so, what aspect of "development," since the US considers it permissible to develop an individual munition to test it for "defensive" purposes? But this presents yet another even more basic problem, as there are no definitions with precisely defined boundaries accepted at an international diplomatic level that clearly separate "research" from "development."[13] On evidence of "testing"? If so, how extensive a testing program, since the US considers it permissible to carry out various degrees of testing for defensive purposes? On evidence of serial or volume production? If so, at what level of production, since small quantities of agent have been produced for defensive purposes? As noted by Howlett and Simpson in 1991, "Small

amounts may need to be retained if defensive equipment is to be developed."[14] None of the above questions has ever been answered.

The following presentation is somewhat unorthodox. Brief descriptions will be given of a half dozen or so aspects that bear on this issue. Hopefully, at the end of the exercise, the issue will be somewhat more clarified, if not more comprehensible.

Who Has An Offensive BW Program?

Since 1988 the US government has repeatedly identified nine nations by name as maintaining offensive biological weapons programs. In the last four years, it has increased the number to thirteen, but has not named the additional four nations. As indicated earlier, the US government made a particular issue at the 2001 BWC Review Conference of alleged non-compliance with the BWC by treaty member states. However, the US government has never disclosed the evidence to support its charges of BWC non-compliance, or to support its charges that particular nations maintain offensive BW programs. It has also never utilized Articles 5 or 6 of the BWC that provide for procedures under the treaty framework to investigate issues of non-compliance. A study prepared by an analytic center of the US Department of Defense in 2001 included a list of "Selected Countries with BW Capabilities." The explanatory comments for individual countries were still full of ambiguous and caveated terms such as "can," "may," "likely," "believed to be" – a common occurrence in public versions of US government assessments for the past twenty years.[15] The remarks associated with two quite important countries, both of which are also nuclear weapon states, made no explicit mention of offensive-related activities. In one case, they referred only to "biological warfare defense research." If that is the case, the two countries in question should not have been in that compilation at all. Most, if not all, NATO member states as well many others have *defensive* BW programs, and they are neither listed nor discussed, nor should they have been. What was the validity of the selection of nations in the compilation?

On May 6, 2002, Under Secretary of State Bolton repeated earlier US charges that "Cuba has provided dual-use biotechnology to other rogue states. We are

concerned that such technology could support BW programs in those states." He continued: "The United States believes that Cuba has at least a limited offensive biological warfare research and development effort."[16] No evidence was offered for the charge. The exact same single sentence, with one additional qualifying word, had already been presented in testimony to the US Senate on March 19, 2002, by Carl Ford, US Assistant Secretary of State for Intelligence and Research.[17] Early in 2002, Bolton had requested the US interagency "intelligence community" to clear an agreed formulation that could be used by senior administration officials for use in presentations to Congressional committees. When Assistant Secretary of State Ford was asked what the difference between an "effort" and a "program" was, he replied that a program would suggest "something much more substantial than what we have seen." A *New York Times* report of Bolton's presentation nevertheless expanded the charge by claiming that "The Bush administration has accused Cuba of producing small quantities of germs that can be used in biological warfare... other administration officials say the united States now believes that Cuba has been experimenting with anthrax as well as a small number of other deadly pathogens that they declined to identify."[18] US Secretary of State Powell qualified the charges by saying "We didn't say it (Cuba) actually had some (biological) weapons, but it has the capacity and capability to conduct such research."[19] On March 30, 2004, Under Secretary of State Bolton repeated his claim "that Cuba is developing a limited biological weapons effort." There were now three qualifiers in the nine words: "developing," "limited," and "effort." Bolton also added one new major qualification: "Existing intelligence reporting is problematic, and the Intelligence Community's ability to determine the scope, nature, and effectiveness of any Cuban BW program has been hampered by reporting from sources of questionable access, reliability, and motivation." Nevertheless, Bolton still labeled Cuba a "BW threat."[20]

The statements are astonishing only in their inadequacy. "Capacity and capability" tells one nothing about whether a nation has an offensive BW program. If it did, it very likely would have to be applied to every country in Europe. The United States has been "experimenting with anthrax" continuously since 1969, as have the U.K., Israel, and other states. The United States, as will be explained below, has also been producing "small quantities of germs" – in fact, anthrax – since 1969, and has been

"experimenting" not with a "small number of other deadly pathogens," but with many dozens of them for the past 30 years. Within days another unidentified US administration official offered that Cuba has "a number of projects that are what could be dual-use things, but they're probably not... I don't know of any tangible stuff that shows yes, they are making anthrax (or anything else)."[21] What was it that distinguished the Cuban "experimenting" from the US biodefense program? If the US charges are not valid, they would undermine decades of US government initiatives which publicly identified governments (except for Israel) that undertook programs to develop any of the categories of WMD, and to curtail those programs.

But what information is available in the public domain regarding research or production institutes in Cuba that are relevant to the question of whether Cuba might be operating an offensive BW program? In October 1996, in a submission to the Fourth BWC Review Conference, Cuba provided a document which listed nine major institutes dealing with molecular genetics, tropical medicine, pharmaceutical research, veterinary research and so on. It stated, however, that "the information compiled in this paper cannot be regarded as exhaustive, but reflects . . . the work accomplished by a group of the most representative institutions."[22] The nine institutions were the following:

1. National Centre for Agricultural Health (CENSA)
2. Centre for Genetic Engineering and Biotechnology (CIGB)
3. Center for Molecular Immunology (CIM)
4. National Centre for Biopreparations (CNB)
5. National Centre for Scientific Research (CNIC)
6. National Centre for Plant Health (CNSV)
7. Pedro Kouri Institute of Tropical Medicine (IPK)
8. Pharmaceutical Biological Laboratories (LABIOFAM)
9. Institute of Veterinary Medicine

However, in its annual submissions under the Confidence Building Measures of the Biological Weapons Convention, Cuba has listed four institutes which include BL 3 (P3) or BL 4 facilities:

10. Instituto de Medicina Tropical "Pedro Kouri," Havana, under the jurisdiction of the Ministry of Health
11. Direccion (until 1996)/Centro (1997) de Investigaciones Cientificas de la Defensa Civil, Havana, under the jurisdiction of the Ministry of Health

12. Centro de Ingenieria Genetica y Biotecnologia (CIGB), in Cubavacan, listed as under the jurisdiction of "government; international organizations'
13. Centro Nacional para la produccion de animals de Laboratorio (CENPALAB), in Bejucal, Havana Province, under the jurisdiction of the Ministerio de Ciencia, Tecnologia y Medio Ambiente

Only two of these four institutes, number 1 and 3, are listed in the first group of nine. Combining the two lists provides one with the names of 11 relevant Cuban research or production institutes.

In a television address on May 10, 2002, Cuban President Fidel Castro denied the US charges and stated that "The doors of our institutions are open. Cuba has nothing to hide."[23] It was a rare opportunity that should immediately have been taken up, and not allowed to go to waste. In an ideal world, either the United Nations Department of Disarmament Affairs, the Organization of American States, or the EU should have offered to send competent professional teams within 24 hours to all eleven of the institutes that Cuba has reported within the BWC framework.

Almost immediately after Castro's statement, President Carter visited Cuba in May 2002. While there he visited the Center for Genetic Engineering and Biotechnology, one of the nine institutes in the first list. Unfortunately, he was apparently not accompanied by any appropriately trained technical personnel. There was no report as to the degree of thoroughness with which he toured the facility, but it was presumably perfunctory. In October 2002 a group arranged by the Washington based Center for Defense Information (CDI) made an informal three day visit to – coincidentally – nine Cuban biotechnology facilities. The nine were the following:

1. Center for Genetic Engineering and Biotechnology (CIGB)
2. Fabrica de Pienso Animal at the Luis Diaz Soto General Hospital ("La Fabriquita")
3. National Center for Agricultural and Livestock Health (CENSA)
4. Laboratorios Davih (DAVIHLAB)
5. Center for Molecular Immunology (CIM)
6. Pharmaceutical Biological Laboratories (LABIOFAM)
7. Pedro Kouri Institute of Tropical Medicine (IPK)
8. Center for Marine Bioactive Substances (CEBIMAR)
9. Carlos J. Finlay Research Institute[24]

On comparing the three lists, the first thing that one notices is that the CDI group visited only five of the combined eleven institutes. Six of the eleven, therefore, were not visited

at all, including two of those with BL 3 or BL 4 facilities. The corollary is that the CDI group visited four facilities not on either Cuban list. One might guess that these four sites would be the least likely to be carrying out any illicit activities.

The CDI visits to the Cuban facilities were stipulated from the beginning as not being intended to serve in any sense as thorough "inspections." However if they had been, what might they have looked for as distinguishing characteristics of prohibited offensive BW programs? In 1993, the Russian Foreign Intelligence Service produced a remarkable indicator list saying that:

"The development, production, stockpiling, and possible use of biological weapons may... be identified on the basis of the following specific indications:

- The existence of programs for training troops, special subunits or intelligence and sabotage groups, for operations involving the use of biological weapons;
- The presence or purposeful search for highly qualified specialists in immunology, biochemistry, bioengineering, and related fields, who have experience in the development of biological weapons and means of protection;
- The building of laboratories with enhanced security [according to international classification P-3 (BL-3) or P-4 (BL-4)];
- The development of secret research programs and secret special and military facilities of biomedical orientation;
- Large-scale production of vaccines (against especially dangerous infections) and the existence of stocks of these vaccines which exceed real peacetime requirements;
- Creation of a production base, specifically of bioreactors and fermenters with a capacity of more than 50 liters or a total capacity of more than 200 liters;
- Outbreaks of especially dangerous infectious diseases not typical of specific regions;
- The purchase of starting biomaterials and equipment for the production of biological weapons, as well as delivery systems for them;
- Activity related to microorganisms and toxins which cannot be explained by civilian requirements, activity involving agents of especially dangerous infections not endemic to a given area;
- The existence of biotechnological equipment and conduct of work to create vectors of various diseases in people, animals, or plants, as well as composite media for culturing them;
- The existence of equipment for microencapsulation of live microorganisms;
- The existence of equipment for studying the behavior of biological aerosols in the environment."[25]

Not the least interesting aspect of this list is that it would always have served as an indicator of the former Soviet BW program. But the list is "superindicative": it of course

identifies the maximum of everything in a large and ambitious national program, even including a potential disease outbreak due to an accident in a BW installation, such as actually took place in the former USSR in Sverdlovsk in 1979.

Somewhat more analytical indicator lists are available from three different US government agencies, dating between 1993 and 2003. The first was prepared by the Armed Forces Medical Intelligence Center in 1993, entitled "Signatures for Biological Warfare Facilities." It divided indicators into five categories:

(1) Funding and personnel
(2) Facility design, equipment, and security
(3) Technical considerations
(4) Safety
(5) Process flow

Under each of these categories, it listed a series of common – or quite dissimilar – characteristics in a "BW facility" and in a "legitimate facility" (e.g., the location of refrigerated bunkers, facility security, the nature of waste treatment, location of air filters, air pressure gradients, etc.) Forty such characteristics were evaluated and appeared to provide quite a reasonable differentiation between a BW facility and a presumptive pharmaceutical or other commercial site.[26]

TABLE 5.1: SIGNATURES FOR BIOLOGICAL WARFARE FACILITIES - I

I. FUNDING AND PERSONNEL

	BW FACILITY	LEGITIMATE FACILITY
1	Military funding	Private enterprise or nonmilitary
2	High salary	Salary within normal limits
3	Funding exceeds product/research output	Average or underfunded for expected output
4	Scientists/technician ratio high	Average ratio
5	Limited ethnic diversity	Integrated work staff
6	Elite workforce/foreign trained	Local trained workforce
7	Foreign language competency	Limited foreign language capability
8	High ratio of military to civilian	Military personnel unlikely

II. FACILITIES, SECURITY, AND EQUIPMENT

	BW FACILITY	LEGITIMATE FACILITY
1	Access control: high walls, guard towers, motion detectors, video cameras, elite security force, badges and clearances	Average security, badges at most
2	Transportation provided	Public/private transport
3	Quarantine facilities on compound	No quarantine
4	Foreign travel restricted, highly available	Unrestricted but not readily available
5	Refrigerated bunkers secure area	Cold rooms in facility
6	Advanced software, external database access ADP security high foreign access	Open information except for proprietary information
7	Static aerosol test chambers	No aerosol test chambers
8	Military with weapons expertise	No need
9	Rail or heavy truck required for weapons filling facility	Only light truck transportation

III. TECHNICAL CONSIDERATIONS

	BW FACILITY	LEGITIMATE FACILITY
1	Pathogenic or toxic strains	Non-pathogenic or non-toxic strains
2	Test aimed at killing animals	Test aimed at protecting animals
3	Facilities for large animals such as monkeys	Facilities for smaller animals, specific inbred strains
4	Negative air flow	Positive air flow
5	No commercial products	Commercial products
6	Weapons filling equipment	Bottle filling equipment

IV. SAFETY

	BW FACILITY	LEGITIMATE FACILITY
1	Physical barriers to prevent animal-to-animal and animal-to-human transmission	Physical barriers designed to prevent animal-to-animal and human-to-animal transmission
2	HEPA filters present, exhaust	HEPA filters possible, intake
3	Dedicated biosafety personnel	May or may not be present
4	Infectious and toxic agent trained medical staff	Dedicated highly trained staff not likely
5	Decontamination equipment and showers	Not needed on large scale
6	Large capacity pass through autoclaves	Small bench top autoclaves
7	Dedicated waste treatment	Waste treatment common with local facilities
8	Special sterilization of waste	May or may not exist
9	Test animals sterilized before final disposal	Animals may not need to be sterilized before final disposal

V. PROCESS FLOW

	BW FACILITY	LEGITIMATE FACILITY
1	Raw material consumption does not equal output	Raw material consumption relates to output
2	Large volume fermenters (greater than 500 liters) cell cultures (1000s of culture flasks/ rollerbottles) embryonated eggs (100s thousands)	Large or small scale fermentation but cell culture and eggs in smaller volume
3	Air pressure gradients keep microbes in vessel	Air pressure gradients keep contaminants out of vessels
4	Finished product—wet stored at low temperature in sealed (often double packaging) containers—not readily identifiable	Labelled by product, batch number, date, etc.

	BW FACILITY	LEGITIMATE FACILITY
5	Milling equipment operated in biohazard protective suits	Milling equipment is not operated in biohazard areas
6	Storage—low temperature, high security, bunkers with biocontainment	Storage in temperature controlled environment, clean warehouse conditions
7	Munitions—special filling buildings and/or explosives handling facilities	Non-issue

The second list provided indicators without contrasting aspects in them,[27] while the third appears to be a partial adaptation of the first.

TABLE 5.2: SIGNATURES FOR BIOLOGICAL WARFARE FACILITIES – II

INDICATORS	FACILITIES	EQUIPMENT	PERSONNEL
• Pathogens Not Endemic to Area • High Security • Dissemination Chambers • Weapons/Filling Equipment • Bulk Stocks – (How Large?) • Publications – None or Decrease • Priority • Military Presence • Elite Workforce • Test Animals • No Commercial Product • Poor Records of "Cover Story"	• Research Laboratories • Scale-Up Pilot Plant • Production Fermenters • Test Chambers • Test Grids • Security • Safety Systems	• Fermenters • Hoods (BL4) • Filters • Centrifuges • Filter Presses • Freeze Drying Systems • Dissemination Equipment • Protective Clothing • Aerosol Chambers • Animal Facilities • Refrigerated Storage Bunkers • Safety Interlocks	• Microbiologists • Bacteriologists • Toxicologists • Virologists • Biochemists • Biotechnology Engineers • Pathologists • Veterinarians • Fermentation Biochemists

TABLE 5-3: POTENTIAL INDICATORS OF BIOLOGICAL WEAPONS PRODUCTION FACILITY[28]

	BW Facility	Legitimate Facility
Funding and Personnel	Military/state funded High scientist/technician ratio (2:1) Elite, foreign trained workforce Military/civilian ratio high	Private/corporate funded Average scientist/technician ratio (1:6) Mostly domestically trained workforce Military unlikely
Technical Considerations *Facility Equipment* *Security*	Pathogenic strains Facilities designed to protect humans from infection Facilities designed for decontamination/disposal of many animals (autoclaves/cremation) Weapons filling equipment Access-control badges, security clearances Restricted transportation Quarantine facilities Refrigerated bunkers Aerosol-explosive test chambers Rail/heavy truck transportation Fences, guard towers, patrol roads, cameras, motion detectors, etc. Military presence	Nonpathogenetic Facilities designed to protect animals Few animal disposals require decontamination Bottle/vial filling equipment Badges Public transportation No quarantine facilities Cold rooms in plant No aerosol chambers Only light truck needed Little to no outside security No military presence
Safety	Physical barriers to prevent animal-animal/animal-human transmission Dedicated biosafety and medical personnel HEPA filters/air incinerators for outflow Decontamination showers Pass through autoclaves (large) and dedicated waste treatment	Not always present Not always present HEPA for inflow Not always present Small autoclaves and use of common facilities
Process Flow	Raw materials do not match output Negative Pressure Finished products stored in bulk and coded Dry product processed in high containment Storage in bunkers, secured, contained and low temperature Munitions-filling and storage facilities Testing/proving grounds	Raw materials limited for legitimate products Positive pressure Product clearly labeled Milling and other equipment not in containment Low security No munitions Not applicable

These indicator lists overlap and individual items can be disputed. In addition, a single indicator—depending on what it is—certainly may not be indicative. For example, the US Centers for Disease Control and Prevention or any laboratory working with filoviruses unquestionably has "Pathogens Not Endemic to Area" in its possession, and

very likely also has "High Security." The "Personnel" grouping in the second list has particularly little value: scientists in those professional disciplines are located in thousands of civilian academic, medical and commercial institutions. Nevertheless it seems clear that the three day visit to nine facilities by the CDI group did not place it in a position to begin an attempt to examine the sites they visited in terms of these indicators, and they did not do so. In addition, conclusions drawn by the visiting CDI group regarding Cuban utilization of its BL3 and BL4 suites were undercut by the fact that they only visited two of the four institutes in which those suites were present.

However, were Cuba to actually be pursuing an offensive BW program, it is questionable whether these are the facilities in which it would be taking place. As early as mid-1963, Dr. Oscar Alcalde Ledon, reportedly a former director of the Cuban Academy of Scientists, already charged that Cuba was preparing biological weapons "in a secret laboratory at Soroa, in Pinar Del Rio Province."[29] It has even been postulated that this charge, carried in newspapers in Miami, Florida, may have been the stimulus for Fidel Castro's first claim, in June 1964, that the Cuban government was investigating a "possible US-instigated germ warfare attack" the previous week. A press item in 1998 included a quotation attributed directly to a leaked US Department of Defense report: "According to sources within Cuba, at least one research site is run and funded by the Cuban military to work on the development of offensive and defensive biological weapons."[30] Elsewhere the report identified a newly built annex to the Luis Diaz Soto Naval Hospital, which is situated within a military compound in Havana, as the suspect site. With knowledge of this leaked report, the CDI group requested that the Diaz Soto Naval Hospital be added to the list of sites that it visited. However, information from defectors or local informants are frequently inaccurate, as the US experience in Iraq in 2003 and 2004 has dramatically demonstrated. If US officials requested the ability to visit such a facility, the chances are that Cuba would demand the reciprocal right to visit a US military facility, a request that the US government would certainly not be willing to grant.

The problem with the Cuban case, as with all the other official US statements

regarding BW treaty noncompliance, is that US officials do not supply any evidence for the charges. As the example of Iraq has shown, US intelligence on other nation's biological weapons programs can be very problematic. If the US statements are wrong, not only do they slide into false allegations, but they undermine the diplomatic position of the US government on disclosures of other nations' WMD activities, including nuclear. That would be extremely unfortunate. It is a valuable asset accrued by previous US administrations, and it is an asset to protect, rather than to destroy.

There is one additional important source of information regarding what indicators on-site inspectors would use to distinguish facilities doing BW work from those carrying out pharmaceutical or other permitted activities. These are the very substantial series of reports produced between 1993 and 2000 as part of the process for the elaboration of the Verification Protocol of the Biological Weapons Convention. These particular reports presented the experience of trial inspection exercises at research or production facilities of different kinds and in different countries. The trial inspection exercises took place in and were reported by an impressively varied list of countries: Canada, the Netherlands, United Kingdom, Brazil, Australia, Denmark, Finland, Norway, Iceland, Sweden, Austria, Iran, Switzerland, Germany, and Spain. [31] The US Arms Control and Disarmament Agency did carry out several more limited visits to US facilities, but because of the agencies' negative approach to the entire Verification Protocol negotiations, the US government did not publicize or report the results.

Official Chinese government positions on these questions are rarely, if ever, heard, but it appears as if Chinese government officials believe that the United Sates has been maintaining an offensive BW program. On one informal occasion at the Ad Hoc Group meetings, one of their officials remarked that offensive and defensive activities were so close that there was basically no difference.[32] Long Zhou, the Deputy Director of the Arms Control and Disarmament Department of the Chinese Ministry of Foreign Affairs, offered a similar opinion at a meeting in Beijing in April 2001: "Defensive BW research can easily be offensive." This is certainly not a unique position: In 1984, Dr. M. Schaechter, then head of the American Society of Microbiology, commented on some US Army biodefense projects that "The difficulty the Army has is that in claiming

they are working on defensive matters, they have to do the same work as on offensive matters."[33] Even earlier, in 1969, when the US still maintained offensive programs in both BW and CW, when a US Department of Defense official was asked to specify the proportion of offensive work in the US CBW R&D program, he replied: "It is difficult to quantify specifically how much exploratory development work is offensive in nature, since much of this work contributes equally to the defensive or the offensive effort."[34]

Nevertheless, a few scattered references to this issue by Chinese military and technical authors show a degree of superficiality and confusion that is puzzling for a large country with sufficient technically qualified personnel and an enormous embassy in Washington, DC, whose staff are able to work freely in an open society. General Pan et al. write that "The US announced that it was giving up development of offensive biological weapons in 1969, but it continued to carry out biological weapons research," and that "although the United States promulgated that from 1969 they would not use biological weapons, they maintained a latent capability in biological warfare carrying out biological defense research at USAMRIID."[35]

Another obtuse and serve-all-purpose assessment written by a member of China's Institute for Chemical Defense in Beijing additionally included a totally fabricated statement attributed to a senior US Department of Defense official:

> The United States policy management system at the highest levels has yet to change with regard to CB weapons. There has yet to be seen a weakening in financial support and R&D. In November 1998, Hans Mark, the US DOD Research and Engineering director, looking 20 years into the future, discussed the aforementioned matter of important weapons research. He pointed out that the United States needs to research offensive biological and chemical weapons, to vanquish those who would use chemical and biological weapons in future wars against the United States and its allies.[36]

Dr. Mark's interview appeared in the November 1998 issue of *Jane's Defence Weekly*, and included no mention whatsoever of US biological or chemical weapons research, neither offensive nor defensive. Apparently the military and technical "experts" advising the Chinese Ministry of Foreign Affairs tell the Ministry that the US maintains an offensive BW program. In the negotiations that led to the drafting of the BWC

Verification Protocol, China expressed strong interest that the US be made to declare all its biodefense activities and facilities.

Cuba has of course been accusing the United States of *using* biological weapons on numerous occasions against humans, plants and animals inside Cuba for decades since 1969, and continues to repeat these claims until the present day. Any nation accused of using BW is also by definition being accused of maintaining an offensive BW program. These charges were discussed in some detail earlier, and outside of Cuba they are universally considered to be fraudulent. The former East German government charged West Germany in 1968 with maintaining an offensive BW program at a time when West Germany almost certainly did not, and when it was forbidden by post-WWII international agreements drafted by the Western European Union from maintaining any programs involving any weapons of mass destruction.[37] These charges are also considered fraudulent. However, in June 2001, a group in Germany, named the "Sunshine Project," charged that the biological weapons defense research projects carried out by the German Armed Forces' medical research laboratories had crossed over from the defensive to the offensive side. It made this argument on at least four grounds:

1. The insertion of an antibiotic resistance gene into a Tularemia strain;

2. That all work on vaccines is "dual use" and includes "offensive" capabilities – if the possessor of the vaccine were itself to use B weapons;

3. That research on Botulinum toxin had included preparatory details on how to produce large quantities of the substance;

4. That by holding samples of various weaponizable pathogens, German military research laboratories thereby maintained "stocks" of agents that could be produced in large quantities for offensive weapons purposes.[38]

The second and fourth of these arguments are unquestionably tendentious and not valid. However in April 2002, an official of the Sunshine Group persisted, being quoted that "the first thing any government or other organization that intends to develop or use the weapons would need is a vaccine for its own troops."[39] The first and third are problematical and disputable and depend on the detailed reasons for their having been

part of the research in question. In the case of the Tularemia experiments, the gene that had been inserted reportedly conferred resistance to tetracycline and chloramphenicol.

As it turned out, the Sunshine Group making these charges could not have been more mistaken in their understanding of what was taking place in the German laboratory, and why. Two genes were involved, not one, one for each of the antibiotic resistance capabilities. However, *neither* was added by the German laboratory. The Tularemia strain had been obtained from the Swedish Defense Research laboratory, a major research center on Tularemia. It already contained both the antibiotic resistance markers, as well as a gene for a green fluorescent protein used in research procedures, when it was transferred to Germany.[40] No one would conceive or claim – or ever has – that the Swedish laboratory was doing offensive BW work. The chloramphenicol gene was there as a holdover from earlier cloning procedures, and in its present form was only a partial gene, and may no longer confer antibiotic resistance. Tetracycline resistance is present to retain the plasmid for the fluorescent protein in the bacterium, as it will lose the plasmid if not cultured in the presence of tetracycline. In addition, the antibiotic resistance genes are in the plasmids, and not incorporated into the bacterial chromosomes, and they are unstable. If one were interested in antibiotic resistance for biological weapon purposes, it should preferably be introduced into the bacterial chromosome so that it stays there.

It is clear that the antibiotic resistant plasmids had been added as cloning markers for experimental purposes, a frequent choice for that purpose due to the simplicity of the subsequent selection process among the bacterial progeny. There had been no intention of producing an antibiotic-resistant pathogen. In addition, tetracycline and chloramphenicol are not the preferred antibiotics for treating Tularemia. Those are rather Streptomycin, Gentomycin, Doxicycline, and several others. The addition of the gene marker had been intended as a research tool, and not in order to develop an antibiotic-resistant weapon strain of Tularemia. In a subsequent publication, the Sunshine Group authors themselves noted that "The use of antibiotic resistance marker genes is now a widely used method in molecular biology. Likewise, many other legitimate civilian biomedical research projects involve transfer of genes that may be

considered as conferring 'military traits'."[41] But they continue to want to argue both ends of the question, and though most recently claiming, in contrast to their original charges, that "it is only basic research," and that "an aggressive intention by the Bundeswehr can surely be excluded," they bemoan that the German Defense Ministry has "still not been able to bring itself to destroy these controversial bacteria" and that "the development of vaccines should immediately be halted."[42]

The general context exemplified by the above charges is spelled out explicitly by Nixdorff and Bender in discussing "modifications of microorganisms of bioweapons significance:"

> Since the advent of genetic engineering, four categories of manipulations or modifications of microorganisms and their products have been the subject of discussion: 1. the transfer of antibiotic resistance to microorganisms; 2. modification of the antigenic properties of microorganisms; 3. modification of the stability of the microorganisms toward the environment; and 4. the transfer of pathogenic properties to microorganisms.
>
> All four kinds of manipulations are possible and are being carried out daily in research laboratories. Some of the most intensive research concerns the elucidation of the mechanisms of pathogenesis. This work is essential for combating infectious diseases. It is hoped that the production of more effective vaccines with less side effects, better diagnostics and new therapeutic drugs will result form this research. At the same time, it is feared that the advances in biotechnology can be misused to develop and produce biological weapons.[43]

As if to demonstrate the point, in April 2002, the same German Sunshine Project released a list of sixteen studies involving genetic engineering being carried out under German Ministry of Defense funding. One of these was the "Development of a recombinant Dengue-vaccine based on attenuated Vaccinia viruses (MVA) as vectors."[44] Contrary to the Tularemia example, in this instance the group made no claim that the research project was "offensive" in character. As will be noted below, the use of Vaccinia as a vector to stimulate immune response is a common technique, but it has produced disputed interpretations elsewhere, which resulted in charges that BW directed research with Vaccinia was being used as a laboratory proxy for smallpox (Variola).

Distribution and Reclassification of Declassified US BW Reports

Another insight into the dilemma of the categorization as well as the subsequent utilization of a particular piece of research comes from the recent US decision to withdraw from distribution and even to reclassify a substantial number of research reports that had been produced during the pre-1969 years during which the US maintained an offensive BW program. The research reports had been declassified in past decades and had been freely available at minimal cost from a US government technical report distribution agency, *to foreign as well as to domestic purchasers.*[45] How and why these reports should ever have been declassified in the first place is a mystery. They most certainly should never have been released at all. They are not "basic science," but frequently technical production and process information, including the detailed processes for producing some of the most dangerous BW pathogens that exist. Their previous declassification and release makes no more sense than would the release of detailed specifications for producing a nuclear weapon. A further irony is that some of these reports were declassified in the mid-1980s, during a period in which Department of Defense officials in the Reagan administration were simultaneously expanding the US biodefense program, and proclaiming very determined views about the inutility of the Biological Weapon Convention because of its alleged unverifiability.

In any case, the reports were released, and in 2002, there was an effort to at least prevent their further distribution through US government sources.[46] Without knowing anything about the original guidelines or thinking behind the original vetting of these studies, their release years ago implies that someone, whether with or without much thought, considered that permissible. Yet it is absolutely certain that the reports which had been released would directly and substantially assist the development of any nation's offensive BW program.

The US Central Intelligence Agency and its Involvement in the US Biodefense Program

An additional insight into the offensive-defensive dilemma is, oddly enough, the discovery that the US Central Intelligence Agency has taken on a significant role in the

US biodefense program in the last few years. The past record of the CIA in CBW-related programs has always been problematic and frequently crossed the line into illegal ventures, even under existing national policy guidelines and US treaty obligations at the time that they took place. During the years that the US maintained an offensive BW program, the Special Operations Division (SOD) at Fort Detrick supported research and products destined for the potential use by the CIA. These included the development of CBW agents for assassination programs, and a covert program of anti-human, anti-crop, and anti-animal agents code-named NK-NAOMI.[47] In 1975, it was discovered that the CIA had disobeyed the 1969 US Presidential orders to destroy all US BW stocks, and had retained a large catalogue of pathogens and toxins for its own use, albeit in relatively small amounts.[48]

The CIA's ventures in the area of "biodefense" in the past 4-5 years have been carried out aggressively, and several of these projects are discussed further in a section that follows. The CIA was responsible for the project which reproduced a Soviet-era BW bomblet, a BW dispersion system, and it seems also for contracting for various other studies dealing with anthrax. [49] The CIA has also been the co-stimulator of the research program planned by the Genome Institute of the US Department of Energy.

"Biodefense" is *not* a mission of the US Central Intelligence Agency, but it is one that the agency has clearly arrogated to itself under the dubious rationale that it is the agency's responsibility "to protect the country." That may very well be the case, but the CIA does not therefore also take over the tasks of the US Coast Guard. Biodefense <u>is</u> the mission, all or in part, of a sufficient number of other US government agencies and facilities, which are perfectly capable of carrying out whatever tasks are necessary. These include the following:

USAMRID (DOD)
Dugway (DOD)
The Center for Disease Control (CDC)
Walter Reed Army Institute of Research (DOD)
Naval Medical Research Institute (DOD)
DARPA (DOD)
Edgewood Chemical Biological Center (ECBC) (DOD)
DTRA (DOD)
Department of Energy (DOE) laboratories
Department of Agriculture
Environmental Protection Agency
and now, even the National Institutes of Health (NIH)

The CIA can obtain any information regarding biological agents that it needs in order to carry out its legitimate activities in the sphere of US national security from these other US agencies or organizations. It has no need to and should not be carrying out either basic or applied research in the area of biological weapons, either directly or through contractors. That contention is validated by an April 2002 government statement in testimony to the US Senate:

> An area of significant multi-agency homeland security collaboration is in genetic sequencing of microbes with possible terrorist implications. The effort is being coordinated through OSTP's Interagency Microbe Project Working Group. All agencies (NSF, NIH, CDC, DOE, DARPA, USAMRIID, CIA, and Agriculture) doing genetic sequencing are participating and agreeing on what should be sequenced, to what level and quality, and who will do the sequencing. This is a real success story as multiple agencies are pooling their resources to attack a part of the bioterrorism threat.[50]

If anyone is likely to overstep US international treaty obligations not to engage in offensive BW programs, there is a good chance that it would be the CIA, or include the CIA. Notably, the biodefense facilities that the US government failed to report in its annual submission of Confidence Building Measures under the Biological Weapons Convention in recent years were those in CIA-contracted and in DOE laboratories.

Generically, the record of intelligence agencies and their involvement with national offensive biological weapons programs is notoriously bad. The USSR's original offensive BW program was organizationally controlled by its intelligence agency at its inception and for some time afterwards. Iraq's BW program was also initiated under the jurisdiction of its intelligence agency and it is still controlled by that agency. It is believed that the same holds for Iran's current BW program. Finally there are the transgressions of the CIA itself between 1969 and 1975. National intelligence agencies should have nothing to do with defensive BW programs. To the degree that they do, it is almost immediately ground for suspicions regarding the activities that are taking place, only the least of the reasons being that they will be secret.

Soviet-era and Russian BW-Related Research: Defensive or Offensive

Research carried out in several countries in the past decade demonstrates without any question whatsoever that the USSR had maintained an offensive BW

program of enormous and unprecedented magnitude. The discussion in the section that follows should not be misunderstood to suggest anything different. It does however demonstrate the difficulty in assessing the character of a particular piece of research when knowledge of the overall program in which it is embedded is absent.

In testimony to the US Senate, and on numerous other occasions, Dr. Ken Alibek, the former Deputy Director of the portion of the USSR's BW program that was carried out in the Biopreparat organization, has charged that research on viral agents being conducted at the State Research Center of Virology and Biotechnology, VECTOR, in Koltsovo, was being done for offensive BW purposes. He charged that "chimeras" of vaccinia and Venezuelan equine encephalomyelitis (VEE) had been constructed, and that the use of vaccinia was a proxy for variola: once the technique had been established, VEE-smallpox combinations would be made for weapons purposes.[51] Officials of VECTOR admitted to having made a recombinant vaccinia which included structural genes of VEE, but they claimed this had been done for a legitimate and in fact quite common reason, to produce a new vaccine for VEE. They claimed that existing live VEE vaccines (TC-80 or 320, or CM-27) were based on poorly attenuated VEE strains which produced a relatively weak immune response as well as attendant side effects, while available inactivated VEE vaccines did not produce side effects but supplied an even weaker immune response.[52] When queried directly, Alibek maintained his original charge and said that he did so because he knew that these experiments had been devised as part of the Soviet-era offensive BW program when he still held his position as Deputy Director of that program, and that the VEE vaccine development story had been the "cover story" for work intended to further smallpox BW development.[53] Another scientist who had worked at Vector, Dr. Sergey Popov referred to this particular Soviet-era project as the "Hunter Program."[54] It would appear however that the Hunter Program referred to another Soviet BW development effort, to incorporate genetic material that would produce particular bacterial toxins – such as the diphtheria toxin as described in Igor Domaradski's book – into various bacterial species that infect humans, but which are not normally lethal pathogens. Instead the work at VECTOR seems very closely related to research carried out at the Viral Division of USAMRIID by Dr. G.W. Korch. Korch used viral "packaged replicans" for vaccine development, and he used an attenuated VEE in attempts to produce vaccines against influenza, Ebola, Lassa, and most recently malaria. The system

also protected against Botulinum toxin. Korch used the same VEE strain in his work that the Russians at VECTOR had used.[55]

It is impossible to resolve the dispute on the basis of the two contradictory claims alone. Although it seems reasonably certain that a Soviet R&D project of this nature did exist, it is not known what point was reached in the program, and very significant questions have been raised by US researchers regarding its technical feasibility. However, it is most certainly the case that vaccinia, as well as dozens of adenoviruses have been used for years now in research laboratories worldwide as "vectors," as they are both exceedingly good at getting inside cells and/or producing a strong immune response. The methodology is widely used in cancer research and in devising gene therapies.[56] The very same technique is also being used for transcellular transport without stimulating an immune response: "In labs across the US and Europe dozens of geneticists are working to create stealthy viruses that can deliver artificially engineered payloads into cells without detection by the immune system."[57]

Although some of this research is involved in efforts to produce vaccines, including for some of the hemorrhagic fever viruses for which no vaccines exist, and could therefore be considered to be within the "biodefense" sector, much of it is taking place entirely within the civilian medical research sector. It is therefore frequently not even a matter of "defensive" or "offensive" BW-related work. As in the Russian case, however, analogous research efforts are also being carried out in Western BW defense facilities in order to develop new vaccines. Very similar work in Russia, at Vector, and in Germany, at the Institute of Virology in Marburg, have used the Vaccinia T7 system as the "vector" in efforts to produce a vaccine against Ebola.[58] In theory, this would permit one to make an "Ebola-smallpox chimera," just as the study previously referred to using a Vaccinia vector to produce an anti-VEE vaccine could be claimed to permit the production of a "smallpox-VEE" chimera. In the 1980s, Dr. Joel Dalrymple working at USAMRIID also used Vaccinia as a vehicle for gene expression in efforts to develop vaccines against Hanta virus, the Rift Valley Fever virus, and the protective antigen protein (PA) of anthrax toxin.[59] Of even greater interest is that Dr. Dalrymple traveled to Akademgorodok, the "Science City," in Novosibirsk, USSR, to discuss this work. Vector, the institute which Dr. Alibek alleges carried out orthopox "chimera" research for weapons purposes, is situated

some 20 km from Novosibirsk, and scientists from Vector attended Dr. Dalrymple's presentation. In addition, they would have known of his published work on the subject.

In other examples, a February 2002 press item reported that work at "Porton Down" in the U.K. included:

- "modifying a smallpox virus with anthrax genes" [most certainly vaccinia, incorrectly referred to as "smallpox"]
- and introducing genetic modifications into the genomes of the pathogens responsible for bubonic plague, tularemia, gas gangrene and typhoid.[60]

A more accurate and meaningful description of the research referred to is that

> "Since 1993 CAMR [Centre for Applied Microbiological Research] and Porton Down have been working on a new acellular plague vaccine. This is a combination of two purified y.pestis antigens (F1 and Vi) [envelope proteins] that are produced as recombinant proteins (rF1 and rVi) in E.coli. The U.K.'s 2001 CBM return also refers to this vaccine work: 'Genetically engineered vaccines against plague, anthrax and Botulinum toxins have now been devised and these vaccines have transitioned to the development phase. These vaccines can be produced in a harmless strain of the bacterium E.coli, and can therefore be produced without cultivating dangerous pathogens... A programme to evaluate current vaccinia strains, with a view towards identifying ways of non-invasive delivery of these vaccines has continued over the past year. Immunisation with these vaccines should include a protective response against smallpox. These vaccines will also be used as vectors to deliver other vaccine antigens. Programmes have also continued to devise improved vaccines against tularemia and meliodosis.... work is underway to produce attenuated strains of the bacteria which might be used as vaccines...we aim to identify protective sub-units from these bacteria.'"[61]

Analogous work with the "gas gangrene" perfringens toxin and vaccinia was published as early as 1991.[62]

Summing up the various examples that have been described, it is evident that one has the very same technique – and frequently using the genomes of the identical pathogens that were at one time or another in recent decades weaponized, produced and stockpiled as BW agents – utilized in work:

- within the former USSR's offensive BW program;
- within Russia's current defensive BW program, as well as within the current defensive BW programs in the U.K. and the US;
- and entirely within the civilian medical research sphere.

Add to this that the current US biodefense program is reproducing experiments and

constructs that were made under the USSR's offensive BW program, and that current medical research includes attempts to reconstitute the strain of influenza responsible for the 1918-21 influenza pandemic, as well as that other civilian medical research involves inserting bits of myelin into viral or bacterial genomes as part of research into autoimmune dystrophy diseases – a technique which was also developed in the USSR's offensive research program, and which is discussed further below – and you have a complex that certainly appears impossible to disentangle or differentiate at the research level looking solely at the isolated research project.

The Extent of the Current US Biodefense Research Program

On September 4, 2001, the *New York Times* carried a report of three projects within the US biodefense program that had been secret and not known to the US public or to the international diplomatic community. In fact, two of the projects had not been known to the responsible individual in the US National Security Council with oversight of chemical and biological weapons issues for the US government. In addition, details of these and other projects subsequently disclosed had not been reported by the United States in its annual CBM submissions under the Biological Weapons Convention, although they should have been reported under the criteria for those submissions. The three projects were:

(1) The attempt to reconstruct a Soviet-designed BW bomblet, and to test its dispersion characteristics, reportedly using a simulant (Project Clear Vision).

(2) The production of a genetically modified strain of anthrax to include the cereolysin gene as well as antibiotic-resistant characteristics (Project Jefferson). This was again a duplication of work that had been carried out during the USSR's offensive BW program, and to test if it overcame the anthrax vaccine used by the US government. It is of particular interest that USAMRIID had earlier decided that it did not want to repeat this Soviet-era work precisely because of its possible infringement of the BWC.

(3) The attempt to purchase all the necessary components and to construct a small BW production site, and to see if this could be achieved covertly, without the effort coming to the attention of other governments, US agencies, or international agencies (Project Bacus). The facility was then to produce a simulant agent. The

purpose of the entire experiment was to see whether detectable signatures would be produced during the procurement, construction, or production phases, or whether the whole process could be achieved without anyone's notice, covertly.[63] The simulant produced was not milled, and respirable particle sizes were obtained by another method.[64]

The first project was contracted for by the US Central Intelligence Agency, the second by the US Defense intelligence Agency (DIA), and the third by the Defense Threat Reduction Agency (DTRA) in the US Department of Defense. Only the first project reached the attention of the US National Security Council, and led to an interagency review process. It was nevertheless approved as being permissible and "defensive," over the minority objections of a legal advisor in the US Department of State.[65] The Department of Defense gave final approval for the production of the genetically modified anthrax in mid-October 2001.[66] The Russian refusal to share a sample of the antibiotic resistant strain of anthrax that it had developed, despite a promise in 2000 to do so, has led to strains with the US government. There was some indication in 2004 that the CIA may be interested in duplicating other work that the USSR carried out prior to 1992 in its offensive BW program. All of these projects are justified under the rubric of "threat analysis" or "threat assessment," phrases which could of course be extended to justifying any project with clear offensive potential. The "threat assessment" framework additionally explains how the Central Intelligence Agency has been able to make its way into the BW defense program.

Two additional significant disclosures followed. The first of these had not been classified, but was known only to a limited technical community. Around 1992, two aerosol test chambers came into operation at the US Army's Edgewood Arsenal in Maryland, for "studying explosive and non-explosive means for delivery of dangerous microorganisms as aerosols." Simulants were studied first; the dispersion of pathogens was to follow.[67] These had apparently previously been explosive test chambers for chemical munitions that were readapted for use with biological agents. One was 70 cubic meters in size; the second was 155 cubic meters in size. A third aerosol test facility was instituted at the Nevada Test Site, perhaps in 1998 or early 1999. This too was retrofitted from an existing explosive test chamber that had been used, in this case, for conventional explosives. Its size and research program are unknown. None of these had been reported by the United States on its BWC/CBM

declarations.[68] The Australia Group uses an export control "trigger" of 1 cubic meter for an aerosol test chamber, and the BWC Verification Protocol would have required the reporting of any aerosol test chamber of 5 cubic meters or larger, as well as any aerosol test chamber used for explosive aerosol testing. All three US aerosol test chambers far exceeded these thresholds, and as indicated, they had not been reported by the US in its CBM documents.

The second disclosure was that the United States had continued producing dry powder anthrax of small particle size at Dugway Proving Ground since 1969.[69] Much of the anthrax was reportedly irradiated while wet, therefore killing it before drying and milling and being used for experimentation.[70] However if most of the anthrax is killed before any further use, it is not clear why a simulant, or the non-pathogenic Sterne strain, or any "plasmid-cured" pathogenic anthrax strain (one from which the plasmids conferring toxicity have been removed by genetic techniques), could not have been used instead of the pathogenic strains. In addition, challenge testing of newly developed anthrax vaccines in animal model trials, for which the Ames anthrax strain had become the standard, is done using wet anthrax, and dry powder would not be necessary.

As indicated previously, there is also now the first indication within the investigation of the US anthrax incidents that the US Department of Defense or the CIA have not yet disclosed all their current programs involving anthrax. In summary, it became clear that in its submissions under the Confidence Building Measures of the BWC that the United States reported *only* biodefense projects carried out within the US Department of Defense and its contractors, but did not report all of these. In addition it did not report *any* biodefense projects carried out within the US Department of Energy or the US Central Intelligence Agency. For the future, it will remain to be seen if the US will also omit reporting of projects carried out in the US Department of Agriculture, the US National Institutes of Health, and after November 2002, the US Federal Bureau of Investigation. There are already reasons to suspect that it may not. The US government is apparently relying on the fact that the CBM form A2, which is to provide information on national biodefense programs, only requests information for facilities which have "a substantial proportion of its resources devoted to the national biological defense research and development programme." In the Assessment report of a meeting of British and US military

officials held in London on November 30, 2000 it was noted that:

> "Legal restrictions on the (US) DOD at several levels impact the ability to conduct research on, develop, and employ non-lethal capabilities . . . The principal treaties and agreements governing the development and use of NLW are broadly discussed in Tab C [these included the BWC and the CWC amongst others] It is interesting to note that in the US these [relevant treaties, including the BWC] do not apply to the Department of Justice (DOJ) or Department of Energy."

The report goes on to suggest as one of the "Recommended Actions; US.. If there are promising technologies that DOD is prohibited from pursuing, set up MOA (Memoranda of Agreement) with DOJ or DOE."[71] The notion that the CWC or the BWC would apply only to one cabinet level agency of the US government - the Department of Defense – rather than to the entire government and all of its actions is of course ludicrous.

A third disclosure, that the US FBI was also going to produce dry powder anthrax of the quality that had been made by the perpetrator of the anthrax mailings in the US in September-October 2001 as a part of the forensic investigation of these events, came in November 2002. Following that disclosure, the US Department of Defense provided written responses to questions from the *Washington Post* which queried its interpretation of the justifiability of these various activities under the BWC. The Department of Defense stated that its personnel "may use live biological agents in a number of research settings: for vaccines and treatment; protective clothing and containment; alarms and detection; and decontamination," and that the Department of Defense ". . . does not set quantitative thresholds for the agents or toxins in its possession," but that ". . . these quantities are generally small."[72]

International response to these disclosures was quite limited, particularly as the weeks which followed were overwhelmed by the post-September 11 events. As of October 2001, it was reported:

> European states, which have staunchly supported the protocol, have remained silent about the reports. According to a European official, the European Union has not yet officially discussed the recent disclosures. But another European official said that many Europeans are concerned about the revelations, which the official said are 'going to make it much easier for others to claim that work they are doing is legitimate biodefense work.' The official added, 'If the US administration had seen such work underway in other countries, then it would be the first to point the finger that this is questionable. And what this does is makes the gray areas

> grayer still between offense and defense and that doesn't help.' The official said that Western governments would bring up this point privately despite assurances from Washington that its programs are 'legitimate and permitted under the convention.'[73]

Brief statements in defense of the legitimacy of the US biodefense program were made in the Geneva negotiations by the representatives of Germany and Australia. Criticism, of the most oblique and mild character, was offered only by Iran and China. This study does not address the development of anti-material BW agents by the US, the USSR, or any other nation, such as might degrade fuels, rubber, electric insulation, etc. The use of such agents would almost certainly violate the BWC. They have nevertheless been the subject of substantial research for many decades.

In mid-July 2002, Dr. R.V. Swamy, identified as the "chief controller of India's Defense Research and Development Organisation (DRDO), an umbrella organization for 51 military laboratories," announced at a news conference that India had "...tested some biological and chemical agents. We do not produce biological weapons but in order to produce safeguards against them we need substances in small amounts and no convention stops us from doing that."[74] The statement was interesting for several reasons. When India ratified the Chemical Weapons Convention in 1996, it declared existing chemical weapon production facilities as well as prior chemical agent production. This had been surprising because in the years before 1996, Indian diplomats had claimed that the Indian government had never even considered obtaining chemical weapons. India, of course, also has nuclear weapons. Of the countries that have obtained nuclear and chemical weapons, very few did not also have offensive biological weapon programs at one time or another. The Indian government conducted a policy review in 1971 of whether or not to obtain biological weapons; however the outcome of this review is not known. It was almost exactly the same time in which India also conducted its review on the question of nuclear weapons.

If one looks at the current US biodefense program overall, and setting aside projects on detection, vaccines, decontamination, and other protective measures, there is sufficient information available to provide an understanding of those portions that might be considered problematic. At the end of 2001, Anna Johnson-Winegar (Deputy Assistant to the Secretary of Defense for Chemical and Biological Defense)

called for research programs that would focus on:

- modeling and simulation (of pathogen releases);
- transport and diffusion of BW agents in a central urban environment, including inside a closed building;
- transmissibility of secondary and tertiary spread, including studies using animal models, and tissue culture models;
- redoing estimates of the LD/50s and ID/50s that had been arrived at in the 1950s and 1960s of pathogens.[75]

The similarity of these renewed study requirements to a research program that outlined US BW vulnerabilities during the period of the US offensive BW program is striking:

> Rationale for Vulnerability Testing. In the beginning and continuing throughout the BW Program, there was a paucity of scientific and engineering knowledge and principles related to the vulnerability of the US and/or its personnel to BW attacks both covert and overt. Vulnerability testing was required to provide information on the agents likely to be used, means of disseminating agents, sizes of areas that could be attacked, environmental effects on agents, obstructive effects of building and terrain on agents, ability to detect and identify agents and areas of the US and its forces most likely to be attacked, the extent of damage possible, and data to devise physical and mathematical models to be used as substitutes for live, open air testing.[76]

Clearly, both in the currently projected US research program described above, and in the "Vulnerability Testing" that was carried out during the years in which the US maintained an offensive BW program, it is inescapable that the exact same information arrived at for defensive purposes could equally be applicable to offensive use. Such studies are already well under way: the aerosol test chambers at the Edgewood Chemical and Biological Center in Maryland and Sandia National Laboratory in California are being used to study "Source Term, Dose Response and Agent Viability."

> Recognizing the gap in adequate understanding and modeling of CB aerosol sources, of the physiological effects of the agents on the general populace and of the viability of threat agents in the environment, the CBNP began development of models that provide additional capability to the CBNP transport codes and tools for assessing the effectiveness of response architectures and augmenting the fidelity of real time predictive capabilities used to guide response actions during a crisis. Three key technical elements are necessary to perform such an assessment:

- Source term models of material released – the dispersal method, the agent type, the amount of agent and its state (gaseous, particulate or both), the size distribution and how the source varies over time
- Dose response models – the effects of various levels of exposure on the public
- Agent viability models – the agent's survivability and potency as a function of environment and time

  "This work will explore and document agent dispersion immediately after release (i.e., the source term). This description of the agent source term is a necessary input to dispersion models that predict agent transport and fate.[77]

This research program includes explosive dissemination testing, and is apparently to include studies on pathogens.

In studies that dealt with an entirely different subset of research work pertinent to BW, the US Department of Energy's "Chem/Bio Nonproliferation Program" (CBNP) in 1997 included two closely related groups of studies, the first of which would seek the structural attributes of toxins produced by human pathogens, while the second sought the DNA sequence based attributes of human disease pathogens.

Structural Attributes of Toxins Produced by Human Pathogens

Determine structures for:

- Lethal factor and edema factor of B. anthracis
- A and B toxins of C. Botulinum
- Inactive mutants of enterotoxin A and B
- Enterotoxin C produced by S. aureus
- Streptococcus pyogenic factor A

Identify structure of target molecules of:

- Botulinum A/B
- Pyrogenic factor A

Sequence-based Attributes of Human Disease Pathogens

Sequencing virulence plasmids of pathogenic organisms

- In FY97, provide finished sequences for plasmids containing the virulence factors for B. anthracis and Y. pestis

Sample sequencing of B. anthracis and Y. pestis

- 1 X coverage of entire genomes in FY 97

Utilization of sequence information

- Searching for genes that influence virulence and antibiotic resistance
- Strain to strain and species to species comparisons

Source: "DOE Chem/Bio Nonproliferation Program [CBNP] Overview," February 6, 1997.

These studies have continued. "Expression Studies of Virulence Factors in Yersinia pestis" at Lawrence Livermore National Laboratories in 2000 sought "to uncover new virulence genes," Sequencing of Yersinia pseudotuberculosis, also at Livermore, would "allow reconstruction of the pathogenicity evolution in Yersinia," and as is now well known, the Institute for Genomic Research was to determine the complete genome sequence of the Ames strain of Bacillus anthracis.[78] Such studies are likely to increase markedly in the next few years with the sharp increase in US funding. However, the mission statement of the agency in the US Department of Energy which sponsors this research claims that its purpose is to "prevent... the proliferation of chemical and biological weapons."

> The mission of the Chemical and Biological National Security Program at DOE's National Nuclear Security Administration (NNSA) is to develop, demonstrate, and deliver technologies and systems that will help prevent the spread of chemical and biological weapons. Furthermore, this program will help the nation prepare for, recognize, and respond to chemical or biological attacks on the civilian population. NNSA's nonproliferation mission has been expanded to explicitly include preventing the proliferation of chemical and biological weapons of mass destruction.[79]

There is absolutely *no* apparent relationship between *any* of the above studies, whose clear and explicit purpose is to elucidate the mechanisms of biological agent virulence and pathogenicity, and a national effort to "prevent... the proliferation of chemical and biological weapons."

As troubling as these projects may sound superficially, the crucial questions are:

- Were similar projects carried out in offensive BW programs, for example in the Soviet BW program (since genome sequencing was not yet practicable in the pre-1969 US and U.K. programs)? If so, in what way, if any, do these current US research efforts differ from those that were done within an offensive BW program?

- To what degree are exactly analogous studies carried out in general civilian medical research funded by *non*-defense related agencies or surrogates for defense agencies such as the US Department of Energy?

Such questions have never been answered, neither in past years, nor at the present

time. The answers may be extremely difficult to formulate, but it is also clear that only in the rarest instances has anyone been interested in formulating them except in the broadest and most general terms, by justifying the research efforts, collectively or individually, as being "defensive" and permissible. As if on cue, to ensure that the problem would be further entangled, the US National Institutes of Health announced its new program of $1.2 billion on "Bioterrorism" research on March 14, 2002: "The NIH unveiled its plans to explain the mesh of basic laboratory research and clinical studies for battling the most worrisome bioterrorism agents: anthrax, smallpox, plague, tularemia, viral hemorrhagic fevers and botulism... particularly studies focusing on the immune system."[80] Of the six major research categories in the "NIH's anti-bioterrorism agenda," two were:

- "Microbial biology including unraveling the genetic structure of each bioterrorism agent, to understand how the bugs cause disease;"
- "Developing the very tools needed to do such research, including more high containment laboratories and animal models of the diseases."

Similar issues arose once before in the United States, not as an abstract theoretical exercise, but in 1986 to1989, an earlier period that had witnessed an increase in US government funding for BW defense research. The entire cumulative expenditure for the period between 1977 and 1986 was approximately $346 million, a relatively limited sum compared to the amounts involved at present; nevertheless it included sizable year-by-year increases.[81] Interestingly, one of the issues debated in this period was a 1984 US government request to build a new large-sized BL-4 aerosol test chamber at the US Army's Dugway Proving Ground.[82] This proposal was rejected by the US Senate. However, following the US Army's submission of an Environmental Impact Statement which covered the entire Biological Defense Research Program, the construction or adaptation of new aerosol test chambers clearly went ahead at other sites, including facilities of the US Department of Energy. These are the aerosol test chambers referred to earlier, which were retrofitted in the 1990s. The Senate debate regarding the aerosol test chamber appears to have dealt primarily with the question of operational safety considerations should it be constructed, that is, that disease agents tested in them should not escape into the surrounding community.[83]

However, the issue of whether testing in such facilities was consistent with US treaty obligations under the BWC, or the differentiation of "offensive" or "defensive"

work, did get introduced. US Senator James Sasser stated that the facility and its projected work program raised "important questions with regard to the potential capabilities for testing and producing offensive lethal biological and toxin weapons."[84] US Secretary of Defense Casper Weinberger replied that the aerosol test chamber would not be used to develop offensive biological weapons and that the US Department of Defense did not intend to violate the BWC Treaty. He added, however, that "To ensure that our protective systems work, we must challenge them with known or suspected Soviet agents."[85] One of the questions posed in the terms of reference for a US Army Science Board study in July 1987, which was prompted in part by the reactions to the Dugway BL-4 facility episode, was "Is the Army engaged in offensive BW activities?"[86] Rather oddly, this question was answered in the report only by an analysis of what "public attitudes" on the question were, and how those might be ameliorated. Beyond that, it was stated only that members of the study group who had been given classified briefings could perhaps answer the question.

In 1988, the US Army reannounced plans to build the aerosol test facility at Dugway Proving Ground. This prompted a joint hearing by three US Congressional subcommittees.[87] A press report noted the following enlightening summary of testimony to the committees:

> Witnesses at the hearing agreed that the primary distinction between permitted and prohibited germ warfare research is the researcher's intention. If it is intended for defensive purposes, it is allowed: otherwise, it is banned, they said.[88]

It is a position that would most certainly be contested by any state asking for clarification of another state's BW program under Articles 5 or 6 of the Biological Weapons Convention, not least the United States.

One effort to examine the 1980 to 1986 US biodefense research program was carried out by Charles Piller and Keith Yamamoto. Since Piller and Yamamoto were suggesting that US biodefense research at the time was suspect for having overstepped into the area of offensive work, or, at best, was serving both offensive and defensive purposes at the same time, their analysis is a useful example of the conclusions that can be drawn when one entertains suspicions about "intent". They examined 329 research projects funded by the US DOD "biotechnology" program between 1980 and 1986.[89] They specify, however, that these 329 projects did *not*

represent a synoptic survey of relevant DOD-funded work, as they were limited by the research project summaries that they were able to obtain, which did not include "several key avenues of research noted in alternate DOD sources." Of these 329 projects, they selected "eighty-six studies that seemed most explicitly 'offensive' in nature." They noted a major effort in studies to examine ways to defeat vaccines, although any biodefense research manager would immediately respond that one must know if one's own protective vaccines are effective, and that there were not simple ways in which the vaccines could be overridden by an attacking pathogen.

Piller and Yamamoto summarized their examination of the 86 studies in the following table.

Potential Offensive Application of 86 DOD Biotechnology Projects

Potential Offensive Application	Number	Percentage
BW agents that defeat vaccines	23	27
BW agents that inhibit diagnosis	14	16
Supertoxins	17	20
Aerosol delivery of BW agents	5	6
Biological vectors for BW agents	19	22
Novel BW agents	51	59
Drug-resistant BW agents	3	3
Highly specific ethnic weapons	0	–
Biochemical (hormone) weapons	1	1
Increased toxin production capability	15	17

They then looked at the four major stated defensive goals of these 86 studies, and listed the "logical applications of the DOD's studies to an offensive program... the offensive applications that might lurk beneath the four major defensive stated goals:

Vaccine development
Novel BW agents
Defeat vaccines
Increased toxin production
Supertoxins

Toxin, antigen isolation/ characteristics
Novel BW agents
Defeat vaccines
Increased toxin production
Supertoxins
Biological vector delivery

Diagnostics/ultra sensors
Biological factor delivery
Novel BW agents
Defeat vaccines

Development/use of antibodies Therapeutics
Novel BW agents
Defeat vaccines
Inhibit diagnosis

Piller and Yamamoto's book does not contain sufficient detail to enable one to understand what criteria the authors used in making their determinations of "potential offensive application," and despite repeated requests, it has now proven impossible to obtain a more detailed understanding from them. Their study can be seen in either of three ways: the conclusions that can be drawn when overall BW program "intent" is suspected; the dual utility of a particular experiment, depending on the overall purpose of the national BW program in which it is embedded; or the relative simplicity of "cover stories" for offensive BW work masquerading as a defensive program.

Should any of this have been surprising? Only one year after President Nixon's 1969 announcement terminating the US offensive BW program, the basic elements of the puzzle were on display and in dispute. When it was reported that some 250 civilian and 190 military scientists who had been working in the US BW program at Fort Detrick and at Pine Bluff Arsenal would be moved to the Dugway Proving Ground to continue their work, and that classified BW research would continue to be carried out at Dugway, a Department of Defense official stated that all of the work at Dugway was "defensive in nature and would not need to be classified." However,

> Other administration sources said the Army's initial list of programs it wanted included under defensive research included a significant effort to develop and produce virulent strains of new biological agents, and then develop defenses against them. "This sounds very much like [what] we were doing before," one official noted caustically.
>
> Another Army request sought approval for research, into something known as synthetic biologicals, a process involving the chemical treatment of biological agents to make them more virulent.
>
> Some officials are convinced that "the National Security Council capitulated to the Pentagon on the key issue of what is – and what isn't – defensive research," one source said. "The President's decision to get rid of this stuff is directly related to the question of who will conduct the defensive research," one source said. "It's all unbelievable if the Department of Defense holds onto defensive research." Work on immunization against possible disease threats could be conducted at HEW's laboratories, the official said.
>
> "It seems obvious that the White House has capitulated to the Pentagon on this point (defensive research)," the official added....
>
> A major argument offered by the military for the classified program at Dugway involves the need for secret analysis of foreign biological materials and/or weapons produced by the US intelligence community.[90]

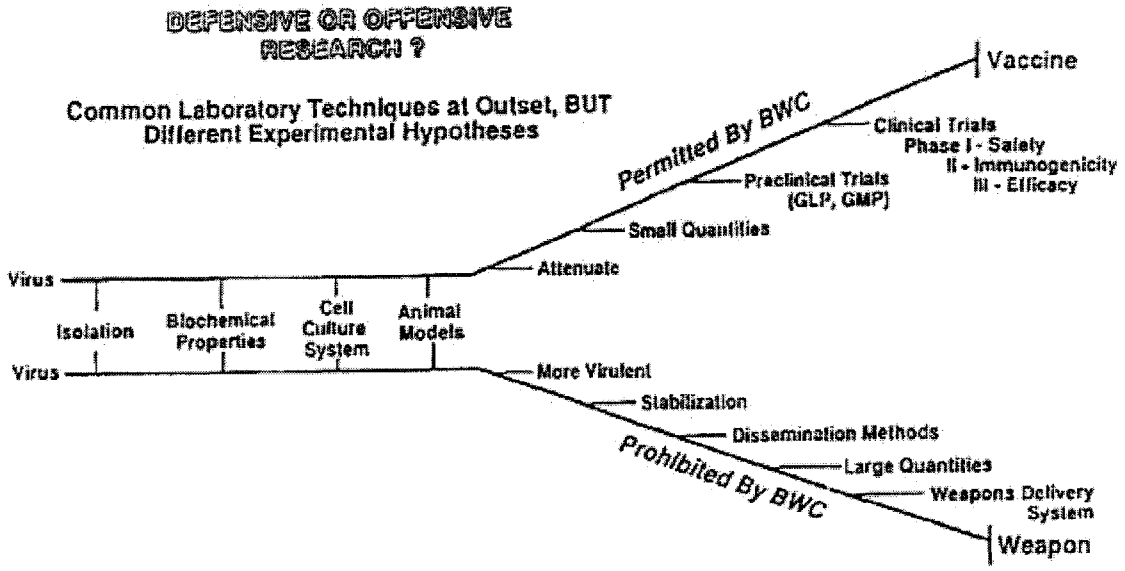
One proposed solution to these kinds of apparent contradictions was 1989 legislation proposed by US Congressman Wayne Owens, to transfer all medical aspects of biological defense research and development from the US Department of Defense to the civilian National Institutes of Health. That, of course, did not occur.[91] However the US Congressional Hearings in 1989 did result in Congressional budgeting and authorization restrictions being placed on work taking placed at USAMRIID. These restrictions mandated that research at USAMRIID be limited to pathogens on the Department of Defense's list of BW threat agents. This in turn led to a substantial number of USAMRIID researchers moving from USAMRIID to NIH and CDC. An argument for the transfer of responsibility for all research on CDC-listed threat agents out of NIH, CDC and into laboratories under the jurisdiction of the Department of Defense or the new Department of Homeland Security – in other words, in exactly the reverse direction – was made in 2003 on security grounds.[92] It is clear that all current trends are going in exactly the opposite direction, at least in the United States, as seen most particularly in the massive entry of NIH into biodefense and "bioterrorism" related work.

In contrast, Colonel David Huxsoll, a former director of USAMRIID, presented a schema in 1989 testimony to Congress that attempted to explain the differences between offensive and defensive research, as well as between the development of vaccines and other defenses and biological weapons. It appeared to be a simple schema, but it explicitly accepted that a substantial portion of early research would serve both purposes.[93] Huxsoll's diagram appears to be a schematic representation of the paragraph in the 1969 NSSM 59 analysis discussed earlier.

> "From the outset, defensive research is based on different postulates and hypotheses than is research directed toward offensive ends, and the rationales for data collection and analysis are different.
>
> At the basic research level, the laboratory techniques used would be very similar, but the objectives are markedly different. Beyond the basic research level, there is a marked divergence in the type of work that would be done.
>
> If a vaccine were to be produced, one would pursue ways of crippling, weaken, or lessening the virulence of the agent in question so that it could be used in humans without fear of inducing disease; in fact, it may be completely inactivated, a killed vaccine.

A vaccine would be produced under stringent guidelines of the Food and Drug Administration regulations and would have to receive FDA approval before use. This type of work is permitted by the Biological Weapons Convention.

If, however, the goal were to create a weapon, the opposite objectives would be pursued. Efforts to enhance virulence or toxicity and to produce enormous quantities of agent far larger than those required for vaccine production would be undertaken. In addition, the issues of stability, dissemination, and weapons delivery systems would have to be addressed. These activities are clearly prohibited by the Biological Weapons Convention."[94]



In questioning by the Senate Committee staff, however, Dr. Huxsoll appeared also to rely on the presence of BL-4 facilities and "program intent" as two key discriminanda. "Intent" is, of course, inferred by an outside observer, and is the troublesome variable we have repeatedly run into. In addition, Huxsoll explicitly places research to produce more virulent agents, stabilize agents, and on "Dissemination Methods" as being "Prohibited by the BWC," and on the "Weapon" side of his schema. As we have just seen, aspects of at least two of these, and "Dissemination Methods" most clearly, are already taking place or are planned for inclusion in the current US biodefense program. Given his position as director of USAMRIID at the time, Huxsoll's schematic description in 1989 had to be cleared through the US Department of Defense prior to its presentation in testimony to the Senate. If the US Department of Defense has now changed its position as to what should be categorized as "offensive" or "defensive," the question is of course why. In 2002, a current senior researcher in the US biodefense program used terms almost

exactly the same as Huxsoll's in 1989: that any research designed to "harden" the pathogen, to increase its virulence, to development adjuvants and additives, all of these concerned weaponization and had offensive implications. Additionally, all this work should remain classified.[95] This may explain why such work was taken up by DOD contractors, the US Department of Energy and the CIA, and is not done at USAMRIID which does not do classified research by policy choice. During the BWC Fifth Review Conference in November-December 2001, Brazil proposed that special attention be given to ambiguous programs, "...and apply, when necessary, consultation and inspection procedures." The Brazilian proposal was not included in the draft final declaration of the conference.[96]

In November 1970, as the negotiations of the BWC were approaching their completion, the disarmament section of the West German Ministry of Foreign Affairs considered the establishment of an international documentation center on both chemical and biological research and development as a verification instrument in connection with the prospective treaty. The conception was modeled after an office within the World Health Organization "which gathered all relevant published information on a particular disease" [cancer].[97] Nothing came of the idea; perhaps it was considered too difficult to carry out in an age of pre-electronic databases. However, the same idea has now been put into practice by the US Army Medical Research and Materiel Command in contracting for the "Development of a Viral Biological-Threat Bioinformatics Resource." The project description reads:

> In response to the potential use of viruses as biological weapons, we have established the Viral Biological-Threat Bioinformatics Resource (VBBR) that collects, catalogs, annotates, and analyzes genetic information related to potential viral threats. This work expands upon available knowledge of virus replication, pathogenicity, and virus-host interactions on the basis of individual protein domains, individual genes, and whole genomes. To date, we have constructed a genome and gene sequence database that has been populated with the sequence information for viruses currently listed on the NIH and CDC priority pathogen list. We have also developed a variety of analytical and visualization tools that aid in the analysis of the genomic information coded for by these viruses. Finally, the information developed as a result of this work has been made available to the scientific community through a (currently access-controlled) web site that supports research efforts to develop environmental detectors, diagnostics, antiviral compounds, new vaccines, and animal models in support of biodefense research goals.[98]

In the previous pages, we have reviewed the question of whether one can distinguish between research that is "offensive" or "defensive – and even whether

this is a meaningful question if "research on offensive aspects is permitted for defensive purposes." We have also seen that "threat analysis" allows one to produce any potential theoretical development of a putative attacker in order to test it: "to test a bullet proof vest one has to have the bullet". But bullets already exist, and are not prohibited. There is then the additional question. To what degree does research that is carried out in the medical research sector, under non-defense auspices and funding, but which is the same, analogous to, or applicable to research that is carried out in a BW program, either defensive or offensive, differ from the latter in any significant way? There are many examples that could be provided. Only a few are indicated below.

(1) Vaccinia is widely used as a "vector" to introduce many different kinds of recombinant genetic material intended for therapeutic or research purposes into mammalian cells. Such Vaccinia recombinants are nothing less than Alibek's "chimeras," which he identifies as an unquestionable part of the USSR's offensive BW program, as well as his reason for suspecting the present continuation of "offensive research" in the same Russian institutes that carried out the pre-1992 research.

(2) A 1996 review of immunotoxin research states that "The use of immunotoxins in the therapy of cancer, graft-vs.-host disease, autoimmune diseases, and AIDS has been ongoing for the past two decades."[99] The most commonly used toxic moieties for making immunotoxins are the bacterial toxins, Pseudomonas exotoxin or diphtheria toxin, or the plant toxins, ricin or abrin.

(3) The US National Institutes of Health (NIH) has for years funded research on plague and plague toxins, the study of basic pathogenicity, and bacterial toxin genes. As already noted, substantial microbiological research is concerned with elucidating the mechanisms of virulence.

(4) The three critical protein components of the toxin responsible for the lethality of anthrax are the lethal factor, the protective antigen and the edema factor. The structure of the lethal factor was identified in 2001, under research funded by the US NIH and the U.K. Medical Research Council. The structure of the edema factor was identified early in 2002, under research funded by the NIH, the American Heart Association, and the American Cancer Society. Other research on the mechanism of

action of anthrax toxins has been funded by NIH.[100]

(5) One of the most troubling paths in the USSR's offensive BW program was the research by Dr. Sergey Popov on recombinant bacterial mediated myelin autoimmunity, carried out at the two premier Biopreparat institutes, first at Vector, in Koltsovo, and then at Obolensk. However, medical researchers who work on multiple sclerosis regularly try to induce autoimmunity in animal models using virtually the same technique. With the pathology induced in the animal model, the researcher aims to reverse or intervene in the course of the disease. Microbial "vectors" have again been used in these studies, and in one study, Theiler's virus (TMEV) was used to introduce a 30 amino acid peptide to produce the experimental autoimmune condition in the research animals.[101] Popov had used the bacterial vector Legionella.

(6) Research to produce a vaccine against the HIV virus has for years spliced various HIV genes into Salmonella.[102] In addition, the University of Pennsylvania Institute for Human Gene Therapy has devised a combination of selected non-pathogenic portions of the HIV and Ebola viruses that were used to test a gene therapy package against cystic fibrosis. The testing model additionally involved aerosol delivery of the recombinant to mice.[103]

(7) There are research projects attempting to reconstitute the 1918 global pandemic influenza strain.

(8) A substantial number of research projects have included the insertion of cytokine genes into poxviruses.[104] This is therefore very similar to the "worst case" BW-related extension of the Australian mousepox experiment which has so widely been seen as the perfect example of extremely dangerous research with BW relevance.

(9) There is extensive research within the pharmaceutical industry to develop methods to stabilize drugs for aerosol delivery, that is, via a small atomizer, for human use. Examples of the drugs include toxins, chimeric toxins, immune system modulators, and bioregulators.[105]

6. Discussion

The purpose of this final portion of the book has been to probe whether one could distinguish between research that was intended to serve an offensive BW

program and that which served a defensive BW program. What are the implications of the information that has been reviewed here? Where does the combination of research taking place in civilian medical research, in biodefense, and in offensive research programs, reviewed in the preceding pages take us? Was the effort useful, or no more than a repetition of the obvious to specialists? And if the answer is that one cannot distinguish between offensive and defensive research, where *is* the dividing line between an offensive BW program and a defensive one? What are the critical indicators? In addition, if it is permissible to carry out offensive research for defensive purposes, is there any sense at all in probing for distinctions between the two?

If we look back at the material gathered on the preceding pages, it could be reorganized into two parts. In "Part A" one could take Alibek's claims of "chimeras" as BW agents, and set against them a panoply of research in the civilian sector, and in both offensive and defensive research programs:

- Vaccinia-Ebola and Vaccinia-Hanta virus combinations used in an effort to produce vaccines against Ebola and Hanta viruses, and similar work with HIV bacterial recombinants;
- The research being done at the U.K. biodefense facility;
- "Stealthy virus" research, and immunotoxin research;
- Work on plague toxins and on anthrax proteins;
- Popov's work at Vector and Obolensk in the Soviet BW program, and the same techniques used in medical research in autoimmune disease research;
- Reconstitution of a critical influenza strain;
- Insertion of cytokine genes into pox viruses.

In "Part B" one could take Huxsoll's 1989 diagram, and use that as a model to apply to various portions of the current US biodefense program:

- The three formerly secret biodefense projects (and others that may exist);
- The size of the US aerosol test chambers, and the nature of the experimentation being carried out in them;
- The new Department of Defense and Department of Energy research programs;
- The Piller and Yamamoto analysis of the DOD biodefense studies in the 1980s;
- The continued production of small amounts of dry-powdered anthrax since 1969.

It was earlier concluded that it was essentially impossible to distinguish

whether the individual items in the "Part A" research, *if examined in isolation*, were offensive or defensive, civil or military. Part B, however, appears much more informative and suggestive. Nevertheless, the problem remains that there are really no internationally recognized boundaries between "offensive" and "defensive". As noted previously, a 1969 British draft for a presumptive Biological Weapons Convention did contain language dealing with research, but that component was set aside by the US and Soviet drafters. The existing language in Article One of the BWC in regard to "prophylactic, protective or other peaceful purposes" is simply at too great a level of abstraction to resolve these issues. Everything is left to an individual nation's claims as to which technical aspects of offensive systems and their operation it must examine in the course of developing an adequate defense. Too much is a matter of argumentation and possibly self-serving interpretation, as was demonstrated in the case of the three US covert biodefense projects.

Switching to the other end of the extreme, if one found BW agents in bombs or shells, or dedicated production facilities with capacities measured in tons, the answer would be obvious, as it was in regard to the USSR and to Iraq. One specialist suggested that if 50 or 100 pounds of agent were found, that would certainly be a definite indicator of an offensive program. However some specialists with long experience in BW programs believe that the first indicators of an offensive BW program become apparent in the development phase. For some portions of the activities that would fall into the "development" category, that is probably the case, but there could even be problems here, depending on which studies were categorized as "development." For example, it would be argued that at some point in actual vaccine testing, animal model exposure must be done with dry as well as with wet formulations of agent, in the same ways that one would expect personnel to be exposed. Is the production of the *dry* agent "development"? UNSCOM assessed Iraq's development of an aerosol dispenser pod for jet aircraft as an unquestionable part of its weaponization program: the dispenser pods accompanied a program that included large-scale production and storage of agents and the accompanying weapon systems. However, a solicitation in 2002 for contracts for the US Army's Edgewood Chemical Biological Center (ECBC) Research and Technology Directorate called for the contractor to "perform theoretical and experimental work necessary to develop and operate dissemination devices for aerosol materials including powders, liquids, and microbiologicals."[106]

It is questionable whether international agreement could be obtained for the point of distinction between "research" and "development." One plausible suggestion is that experimentation on the marriage of an agent with a munition or a dispersal device would cross that line of distinction, presumably including any weapon test using a simulant. But what did the US and U.K. use as criteria in the early Trilateral visits to former Soviet BW institutes? Did the US and U.K. make their judgments on the basis of what was visually seen, equipment and facilities, or did they use other intelligence to critically inform their judgments? And what were the criteria used in judgments publicly released by the United States in the 1980s on the nature of the USSR's BW program and ostensibly based on remote satellite reconnaissance photographs?[107]

One piece of interesting testimony was provided by one of the US participants in the Trilateral visits to Russian facilities in 1993. The US and U.K. team had visited three sites that were "mobilization capacity" facilities, intended for BW production in the mobilization period prior to an anticipated war. Some aspects of these sites were certainly suggestive of offensive capabilities – the massive fermentation capacity, as well as particular aerosol test chambers – while other portions could be interpreted as "dual use" equipment with civilian purposes. The fourth site visited was a research facility: no large production capacity, no bunkers or locations for stockpiling, no weapon-filling lines. Everything seen was in the research phase, but did include static and dynamic test chambers. Nevertheless, in a visit to only two floors of a multi-story building, at a facility which included several dozen buildings, one very experienced US member of the visiting team decided that he was looking at laboratories that were part of an offensive BW program. And the decisive cue for this individual was the overall layout of the sequence of laboratories, permitting him to come to a decision of "offensive" –on the basis of the laboratory layout design.[108]

One should add here the verification problem that arises with the possibility of dual use of commercial vaccine production units that produce inactivated vaccines. There would be little or no difference in the external characteristics of a facility producing an inactivated vaccine of a pathogen, in which an unattenuated pathogen is inactivated subsequent to growth, and one in which the pathogen was being grown for weapon use. The indicators would be, most critically, the volume of production, as the amounts required for vaccine production are very much less than for military

use, as well as any subsequent processing, such as drying, milling, and so on.

In the case of Iraq, one can look at the example of the Al-Hakam facility which Iraq had declared to UNSCOM as a factory for producing single-cell protein. The facility was built in the desert 60 kilometers south of Baghdad. The site spread over an area of 3X6 km. It was secured by a high fence and guard towers and buildings were widely dispersed across the site. It also included underground cold storage bunkers. Nevertheless, pre-war intelligence about Iraqi BW did not refer specifically to the site. UNSCOM's first visit to Al-Hakam, "BW-2", took place in September 1991. One team member, Dr. David Kelley, was reasonably convinced that he was looking at a BW production facility because of what was found in particular buildings at the site. Other inspectors nevertheless interpreted the same indicators differently and no firm conclusions could be drawn.

> The Hakam site was constructed in great secrecy, at a remote desert location, with extensive security and military fortifications. The site included sophisticated air filtration systems (using HEPA filters) on some buildings, for both incoming and outgoing air. These features all implied a use inconsistent with the facility declaration... Yet these indicators were only circumstantial and Iraq maintained its assertion that the site was intended solely for the production of single cell protein animal feed.[109]

UNSCOM Mission #72 visited Al-Hakam again in April and May 1994, but still did not resolve the question. Iraq's explanations for the uses of particular pieces of equipment did not match visible evidence, nor did they match calculations attempting to establish if those explanations were plausible. Despite this, the leaders of the inspection team were still dubious that the facility was devoted to BW production, and they essentially disagreed with the analysts combining different streams of evidence. Opinions at UNSCOM headquarters in New York City had differed sharply on the interpretation of the site in particular and about the likelihood of there having been an offensive Iraqi BW program in general. Even after a special consulting panel in May 1994 convincingly agreed with the analysts, opinions at UNSCOM's headquarters continued to be sharply divided about Al-Hakam through the summer and fall of 1994. The indicators were suggestive and incriminating, nevertheless, short of obtaining official Iraqi records or admission of BW production at Al-Hakam, or identifying pathogens from sampling within the production building, it was only by the accretion of interrelated lines of evidence that UNSCOM arrived at its determination that Al-Hakam was a BW production site. Ironically, a significant

portion of such evidence was a clear record of persistent Iraqi lying in the face of evidence and Iraq's inability to substantiate its cover story of civilian production at the site. UNSCOM's chief BW inspector, Dr. Richard Spertzel, stated that "If UNSCOM had insisted on finding a 'smoking gun,' we might not have forced Iraq into acknowledging its BW program. Most of our evidence was fragmentary but collectively could not be explained except by a weapons program."[110] The accretion of evidence and superb analysis is graphically laid out in Tim Trevan's 1999 history of UNSCOM.[111] The most interesting aspect of the story certainly is how the case was made. But of nearly equal interest are the differing interpretations that some UNSCOM inspectors and New York staff held at different stages in the process in the face of that same superb analysis, and why that was so.

The restrictions that UN Security Council resolutions placed on Iraqi's subsequent ability to carry out defensive BW-related research are also relevant to the questions discussed here:

> Iraq is... totally prohibited from conducting any type of military biological research, even defensive, without first submitting to UNSCOM, and receiving approval for, a plan of activities. This prohibition covers any research by military personnel, in military facilities, administered by military organizations, or biological activities that are classified or secret... Unlike the chemical and nuclear monitoring regimes, there are no strictly prohibited objects, beyond the general phrase 'biological weapons... stocks of agents... and all related sub-systems.'[112]

There was also no intention that Iraq should be able to continue any BW-related work in "civilian" medical research or public health facilities. That was the explicit purpose of UNSC Resolution 715, which established the long-term monitoring system that was designed to prevent the reconstitution of any Iraqi WMD programs, in *any* facility, through the use of dual purpose technology.

In a 1994 analysis that dealt with the conversion of research facilities that had been integral parts of the former USSR's offensive BW program, several basic requirements were set out:

- an absolute end to all offensive work;
- the termination of administrative control by national military or security agencies or their proxies. The transfer of management of such institutions to civilian ministries or branches of government;
- the termination of funding by military agencies;
- transparency: the ending of secrecy and closed facilities.[113]

It is not clear whether all of these four conditions are relevant to the questions under consideration here, which do not concern explicit demilitarization and conversion of facilities but rather routine ongoing peacetime biological research programs, either offensive or defensive. The above are all "non-specific" conditions, and do not address the nature of particular lines of research. It is clear that national defensive BW programs will be primarily based in facilities that are part of and are funded by Ministries or Departments of Defense. Such ministries also maintain major extramural funding programs as part of their defensive BW research programs which support program-oriented research in academic and commercial institutions. In the US, we additionally see very significant portions of the BW defense research program being situated in the Department of Energy, as well as yet other portions under the jurisdiction of the Central Intelligence Agency. At the same time, the US National Institutes of Health has embarked on a major expansion of essentially overlapping work. In contrast, in the U.K., CAMR, the Centre for Applied Microbiological Research moved out of the BW domain, took on a public-health mission while retaining a substantial portion of its earlier work, but most recently has been increasingly drawn back into defence work.

However if one looks at the institutes in Russia that had participated in the USSR's pre-1993 offensive BW program and that remain in operation, one still finds the following:

1. the presence of members of the government's security service still situated at the institutes and performing counterintelligence work;
2. the practice of classified PhD theses still being prepared at the institutes, at least as of 1995;
3. the existence of a government edict prohibiting the discussion of the pre-1993 program, one consequence of which is the appearance of "legends" – cover stories – in the curricula vitae of researchers;
4. the most senior military and civilian administrators of the pre-1993 offensive BW program still involved for the past decade and currently in various government and management positions related to the former BW research and development institutes.

Several individuals with long experience in the biodefense programs of their own countries – the UK, US, Sweden and Russia – however, expressed the opinion that *transparency* was the key factor in removing questions about whether a BW program was offensive or defensive: the ability to display the site to any international visitor and to say "Here is the site, and here is what we are doing."[114] Ken Alibek, in

commentary on the work being done on recombinant pathogens in the US biodefense program – work analogous to the recombinant work that he has repeatedly identified as being offensive in character in the USSR and Russia – stated "that the work had to be done openly if done at all. It can't be classified... If the secret research was essentially disclosed... the United States would be accused of cheating on the germ treaty."[115] Obviously then, one of the best ways to provoke suspicion is to carry out secret BW-relevant research by or under the aegis of an intelligence agency rather than in the customary national BW defense programs. As emphasized earlier, one conclusion that it was relatively easy to arrive at was that BW defense programs should be kept clear of national intelligence and security agencies. However, some biodefense research carried out in more typical national BW defense programs is also maintained at classified and secret levels.

When US and other international assistance programs were devoted to assist the conversion of former Soviet BW facilities, a corollary of these considerations came into play. Obviously one would not want funds supplied to facilitate conversion to find their way into supporting continued offensive programs.[116] The same concern has broader implications as well. Any government, international organization, or research institute that funds work in another country, whether that country has already been identified as being of BW proliferation concern or not, should in theory examine the projects that it supports to be certain that support is not being given to the infrastructure of a BW program. However, given the discussion in the preceding pages describing the intertwining of civilian and military, offensive and defensive BW relevant research, arriving at such certainty is obviously not an easy task. For example, it is known that Russian scientists have been training Ph.D. level molecular biology students at the Pasteur Institute in Tehran for the past half dozen years. The Russian scientists are members of the staff of institutes belonging to the Russian Academy of Sciences. However, several other Russian scientists who appear to have had closer links to the former Soviet BW program are known to be working elsewhere in Iran.[117] The United States has since 1988 identified Iran as maintaining an offensive BW program. US officials have also publicly raised the issue of Iranian researchers being trained in Cuban biotechnology and molecular biology institutes, and have attempted to pressure Cuba to terminate that exchange program. Are these two Iranian training programs innocuous, and the same that might be obtained in any US graduate school? Possibly. Some Iranian scientists are also trained at the

Pasteur Institute in France. But what if on completion of their studies, the doctoral students take their knowledge and join a national offensive BW program? Iraq, after all, sent many of the researchers destined to take on important positions in its BW program to get their advanced degrees in the U.K. or in Germany before returning home to join Iraq's BW program. The issue is similar to that of the Bushehr nuclear power reactor that Russia is building for Iran despite US protests. The reactor is not considered to have direct proliferation consequences – unless the core were to be diverted. US opposition to the project is based on the training that will be provided to Iranian nuclear physicists, which could then be applied in a nuclear weapons program.

Several major points have been argued in the chapters of this book:

- that the threat assessment, most particularly regarding "BW terrorism" – the potential for BW use by non-state actors – has been greatly exaggerated. The US anthrax events in September-October 2001, and the demonstration of *other* initiatives and capabilities by the Al Queda organization on September 11, 2001 – the use of large commercial passenger aircraft as guided missiles –made it even easier to continue that exaggeration.
- The portrayal that was chosen by the US government and by important public figures to describe the alleged threat has very likely served to stimulate rather than to inhibit interest in BW by other states and non-state actors. It now appears that this did in fact occur; the Al Queda group being one case specifically identified so far.
- If one accepts these arguments, then the attention, policy focus, and resources devoted to anticipating a potential BW terrorist event in the US have been disproportionate, particularly in comparison to a long list of existing public-health conditions with individual mortality levels in the tens and hundreds of thousands of people per year, year after year, and cumulatively, in the millions per year.
- The final consideration is the suggestion that expanded BW-related research programs will serve as a stimulus to BW proliferation. The major increase in biodefense R&D in the US and elsewhere will very likely also serve to increase the wrong kind of interest in BW. Many will claim that the increase in biodefense research is an absolute necessity. If so, it is not an unalloyed good, and the

ultimate cost should at least be recognized.

It has been repeated for nearly two decades that the rapid advances of molecular genetics and biotechnology as well as the global diffusion of knowledge and the relevant professional training would facilitate the proliferation of biological weapons. With this went the insistence that the spread would include diffusion to non-state actors. So far that spread has actually been quite limited. The inception of those state BW programs that are known or suspect all apparently date to the late 1970s or early 1980s – over 20 years ago. As regards non-state actors or terrorist groups, the capability has almost without exception not yet appeared in the possession of non-state actors and only two groups have made attempts to obtain it. The perpetrators of the recent preparation and distribution of anthrax in the United States may be the significant break in precedent, but the interpretation of that will depend on who the responsible party turns out to be. It appears extremely probable, however, that the enormous upsurge in the research effort devoted to BW-relevant pathogens, most particularly in the United States – in addition to the generic structural factor of advances in molecular biology – will provoke and direct renewed interest in BW on the part of states. As this is a prediction, confirming evidence obviously cannot be given at this time, but it will certainly facilitate the ability of other nations to justify secret programs, following the example already provided by the United States. The interest in BW will be broadened, provoked by continuous general discussion, new institutional and educational programs, administrative bureaucracies, and specific weapons-relevant research efforts and the new knowledge generated by those studies. In the words of a brief summary produced by the US Central Intelligence Agency in 2003:

> The same science that may cure some of our worst diseases could be used to create the world's most frightening weapons. The know-how to develop some of these weapons already exists.[118]

Will there be any effort by governments or by the international community to control either "progress" or process? Or – as the case has been historically in offensive-defense interactions – will the nations with the most advanced technological and scientific capabilities push research programs, always with the traditional rationale of the needs for defense – "run harder," to "stay ahead" – thereby accelerating the whole.

And is control possible? The study published by Australian researchers in

2001 which added an interleukin gene to mousepox and thereby produced a pathogen able to override the protection of vaccination in mice was referred to earlier. In 2003 a US researcher, Dr. Mark Buller, deliberately carried this one step further by introducing the same interleukin gene in cowpox – vaccinia – which is the current basis for all human vaccines against smallpox. This clear effort to increase the virulence of the pathogen was done under grant funding by NIH/NIAID despite explicit warnings after the publication of the earlier mousepox work that the technique could be used to produce deadlier biological weapon agents.[119] Buller justified his work by arguing that it "...is necessary to explore what terrorists might do."[120] "Terrorists" are decades from this level of technical proficiency, and it is not a serious argument, unless the "terrorist" was as capable as Dr. Buller. If anything, Dr. Buller simply provided guidance for any that aspired to match him at some future time. In another example, despite the explicit warning that a genetically modified flu genome could be adapted as a biological weapons, research continues in an effort to both isolate the genome from the flu strain responsible for the 1917-1921 international flu pandemic from archival or recovered tissue samples, or to reconstruct it in the laboratory.[121]

One research breakthrough after another has followed in recent years, while the miniscule consideration of the problem that exists has been tedious and inconclusive. In 2003, the US National Academy of Sciences published the results of the eighteen month-long deliberations of an Academy-appointed Committee.[122] The Academy has already convened a successor panel, the Committee on Advances in Technology and the Prevention of Their Application to Next Generation Biowarfare Agents, whose task it is to look five to fifteen years ahead and which will undoubtedly be at work for the coming two years. The US government's response to the initial Academy report came after a half year's delay. It established an advisory board "to advise all Federal departments and agencies that conduct or support life sciences research that could fall into the 'dual use' category."[123] But the advisory board will meet only on a quarterly basis and its considerations will apply only to federally funded research. It will have no real authority. Most restrictive of all, it will exclude from its oversight and consideration all classified government research, exactly the type of research in which the most problematic examples are likely to be found. A project at the Center for International and Security Studies at the University of Maryland (USA) is attempting to develop an organizational framework involving

local, national and international scientific review panels to provide oversight of research in molecular biology and to establish an international norm for identifying and managing in advance "experiments of concern" which could result in dangerous consequences.[124] Such a system is urgently needed, sensible and desirable, but the resistance to be overcome in establishing it even on a national basis, not to speak of internationally, is enormous.

Will any control be possible?

ENDNOTES

[1] "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction," in *Arms Control and Disarmament Agreements: Texts and Histories of the Negotiations*, 1990 edition, Washington, DC: United States Arms Control and Disarmament Agency, pp. 133-137.

[2] The U.K. draft language read as follows:

"Article II. Each of the Parties to the Convention undertakes
(a) not to produce or otherwise acquire, or assist in or permit the production or acquisition of
(i) microbial or other biological agents of types and in quantities that have no independent peaceful justification for prophylactic or other purposes;
(ii) ancillary equipment or vectors the purpose of which is to facilitate the use of such agents for hostile purposes;
(b) not to conduct, assist or permit research aimed at production of the kind prohibited in sub-paragraph (a) of this Article."

ENDC 255, July 10, 1969. Reprinted in *Documents on Disarmament, 1969*, US Arms Control and Disarmament Agency, pp. 324-326.

[3] Disarmament Conference Document, ENDC/231, August 6, 1968.

[4] Milton Leitenberg, "Research and Development in (C)BW: On the Distinguishability of Basic vs. Applied, Civil vs. Military, Offensive vs. Defensive. An Example of the Interrelations of Scientific Research and Weapons Development." An updated version of this paper was included as a chapter in a book-length examination, *Studies of Military R&D and Weapons Development*, prepared for the Ministry of Foreign Affairs of Sweden in 1984, as background material for a United Nations Secretary-General's study of military R&D.

[5] Raymond A. Zilinskas and Tazewell Wilson, "Introduction," pp. xi-xii, in *The Microbiologist and Biological Defense Research: Ethics, Politics and International Security*, Annals of the New York Academy of Sciences, ed. Raymond A Zilinskas, vol. 666, 1992.

[6] "Scientific Principles to Guide Biological Weapons Verification," American Society of Microbiology, May 21, 1993. Reference to intent in fact became something of a cliché, as in the remark made in 1984 by a former director of research at Fort Detrick, Dr. William Beisel, that "It all comes down to intent... with technology plus intent you can do great good or great harm."

[7] R. Jeffrey Smith, "The Dark Side of Biotechnology: Experts Say That Recent Scientific Achievements Threaten an International Treaty Banning Biological Warfare," *Science*, (June 15, 1984), pp. 1215-1216.

[8] Ronald J. Jackson et al., "Expression of Mouse Interleukin-4 by a Recombinant Ectromelia Virus Suppresses Cytolytic Lymphocyte Responses and Overcomes Genetic Resistance to Mousepox," *Journal of Virology*, February 2001, pp. 1205-1210; Elizabeth Finkle, "Engineered Mouse Virus Spurs Bioweapons Fears," *Science*, 291, (January 26, 2001) p. 585.

[9] "Nuclear, Biological, and Chemical Warfare Defense," Office of the Special Assistant for Gulf War Illnesses, Medical Readiness, and Military Deployments, US Department of Defense, January 8, 2002.

[10] National Security Decision Memorandum 35, "United States Policy on Chemical Warfare Program and Bacteriological/Biological Research Program," November 25, 1969. Declassified.

[11] "US Policy on Chemical and Biological Warfare and Agents: Report to the National Security Council," Submitted to the Interdepartmental Political-Military Group in response to NSSM [National Security Study Memorandum] 59, November 10, 1969, p. 26. Declassified.

[12] Forrest Russell Frank, "US Arms Control Policymaking: The 1972 Biological Weapons Convention Case," Ph.D. Dissertation, Stanford University, California, November 1974, p. 239.

[13] The US National Science Foundation (NSF) uses the following definitions:

Basic research: Basic research has as its objective a fuller knowledge or understanding of the subject under study, rather than a practical application thereof. As applied to the industrial sector, basic research is defined as research that advances scientific knowledge but does not have specific commercial objectives, although each investigations may be in fields of present or potential interest to the reporting company.

Applied research: Applied research is directed toward gaining knowledge or understanding necessary for determining the means by which a recognized and specific need may be met. In industry, applied research includes investigations directed to the discovery of new scientific knowledge having specific commercial objectives with respect to products or processes.

Development: Development is the systematic use of the knowledge or understanding gained from research toward the production of useful materials, devices, systems, or methods, including design and development of prototypes and processes.

National Science Foundation, *Science and Engineering Indicators – 1989*, p. 89.

The US Department of Defense also has RDT&E definitional categories, but these have no application beyond US DOD decision-making for acquisition and procurement. The most relevant of these are:

Research: Includes all effort directed toward increased knowledge of natural phenomena and environment and efforts directed toward the solution of problems in the physical, behavioral and social sciences that have no clear direct military application.

Exploratory Development: Includes all effort directed toward the solution of specific military problems, short of major development projects.

It is possible that some combination of these could be adapted for international diplomatic use, but that is difficult to envision.

[14] Darryl Howlett and John Simpson, "Dangers in the 1990s: Nuclear, Chemical and Biological Weapons and Missile Proliferation," in *Disarmament: Topical Paper 6: Confidence Building Measures in the Asia Pacific Region*, New York: United Nations Department for Disarmament Affairs, 1991, p. 38.

[15] *The Counterproliferation Imperative. Meeting Tomorrow's Challenges*, A Report of the Center for Counterproliferation Research, National Defense University, November 2001, p. 38.

[16] John R. Bolton, "Beyond the Axis of Evil: Additional Threats From Weapons of Mass Destruction," Heritage Foundation Lectures, no. 743, May 6, 2002.

[17] Ford's testimony to the US Senate Committee on Foreign Relations read: "The United States believes that Cuba has at least a limited developmental offensive biological warfare research and development effort."

[18] Judith Miller, "Washington Accuses Cuba of Germ-Warfare Research," *New York Times*, May 7, 2002.

[19] David Gonzalez, "Carter and Powell Cast Doubt on Bioarms in Cuba," *New York Times*, May 14, 2002; Mark Fineman, "Carter Doubts Claim of Cuba Bioterror," *Los Angeles Times*, May 14, 2002.

Notably, both headlines in two of the best newspapers in the United States, misrepresent the original US charge: it referred neither to "Bioarms," nor to "Bioterror."

[20] Testimony by Under Secretary of State for Arms Control and International Security John R. Bolton to the House International Relations Committee, March 30, 2004 and "Cuba is a Bioterror Threat to United States, Bush Diplomat Charges Again," Agence France Press, March 31, 2004..

[21] Kevin Sullivan, "Carter Says He Was Told US Had No Proof Cuba Shared Bioweapons Data. State Dept. Officials Claim Contradicted," *Washington Post*, May 14, 2002. (The *Washington Post* headline

is a misrepresentation. Carter stated only that he had asked about possible Cuban information-sharing "for terrorist purposes," and *not* regarding Cuba's own BW program.)

[22] "Background Paper on New Scientific and Technological Developments Relevant to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction," BWC/CONF.IV/4, October 30, 1996, pp. 1-5.

[23] "Castro's Response to Statements Made by US on Biological Weapons," Havana AIN (Internet Version-www), LAP200020511000011, May 11, 2002. See also, "Castro Sees 'Sinister' Move in US Biowar Charge," (Reuters Dispatch), *New York Times*, May 10, 2002,; "Biological Weapons: US Should Present Evidence of Cuban Threat," *Dallas Morning News*, May 9, 2002; and David Gonzalez, "Castro Says Carter Can Inspect Biotechnology Centers," *New York Times*, May 13, 2002.

[24] Glenn Baker, Editor, *Cuban Biotechnology: A First Hand Report.* The Center for Defense Information, Washington, D.C., 2003.

[25] *Proliferation Issues: A New Challenge after the Cold War: Proliferation of Weapons of Mass Destruction*, Russian Federation Foreign Intelligence Service Report, 1993. Also in JPRS-TND-93-007, March 3, 1993, p 15–16.

A briefer tabulation of indicators was provided by the director of biological research at a French military laboratory who listed the following in 1992 as "indicators of strategic BW development:" "large scale production of an agent, the existence of certain storage facilities, the use of certain equipment such as fermenters and freeze drying equipment, and the safety protection being provided personnel." [Quoted in *Arms Control: US International Efforts to Ban Biological Weapons*, GAO/NSIAD-93-113, December 1992, p 21.]

When US satellite intelligence photo-interpreters in the mid-1970s identified tall incinerator stacks, large cold storage facilities, animal pens, sentries and double barbed wire fences in a Soviet military compound in Sverdlovsk, they suspected it of being a BW laboratory—which it was. Both the Russian and French compilations, however, are at the high end of the indicator spectrum. Of course, the use of fermenters alone would not be indicative; all would depend on what was being grown in them. In addition, more recent technology could reduce the need for large stockpiles that were previously held in readily recognizable storage facilities, depending on the procedures that a nation chose to implement.

Raymond Zilinskas, a BW proliferation analyst, suggested that: ". . . verifying that no BW-related work is taking place in a given nation's P-4 (BL-4) research laboratories is probably the single best measure indicating that the nation in question is indeed not involved with BW." [Raymond Zilinskas, "Verification of the Biological Weapons Convention," Chapter 7 in Erhard Geissler (Ed), *Biological and Toxin Weapons Today,* SIPRI, Stockholm International Peace Research Institute, Oxford University Press, Oxford, 1986, p 85–107.]

Notably, this suggestion left unanswered how one decided what "BW related work" was in the first place. In addition, not only did Iraq have no BL-4 facility—the highest safety levels that its BW research and production facilities reached might be termed "BL-2 plus" by the criteria used since the 1960s—but the safety levels in the BW programs of the WWII belligerents that had offensive BW programs had no higher safety levels than the same "BL-2 plus."

[26] Signatures for Biological Warfare Facilities, Armed Forces Medical Intelligence Center, 11 pages, (unclassified).

[27] Source unidentified

[28] US Government, *The Worldwide Biological Warfare Weapons Threat*, 2001, p. 45.

[29] Seymour Hersh, *Chemical and Biological Warfare. America's Hidden Arsenal*, Indianapolis: Bobbs-Merrill Company, 1968, pp. 20-21.

[30] Martin Arostegui, "Fidel Castro's Deadly Secret – Five BioChem Warfare Labs," *Insight Magazine* [Washington Times], 14:26 (July 20, 1998).

[31] *AD HOC GROUP OF STATES PARTIES TO THE BTWC: LIST OF DOCUMENTS ON TRIAL INSPECTIONS/VISITS,*

BWC/CONF.III/VEREX/WP.112	The Netherlands-Canada; Bilateral Trial Inspection in a Large Vaccine Production Facility; A Contribution to the Evaluation of Potential Verification Measures. May 24, 1993.
BWC/SP/CONF/WP.2	United Kingdom BTWC Practice Compliance Inspection (PCI) Programme, Summary Report. September 20, 1994.
BWC/SP/CONF.III/VEREX/WP 141	UK Practice Inspection: Pharmaceutical Pilot Plant. May 24, 1993.
BWC/SP/CONF.III/VEREX/WP 147	UK Practice Inspection: Pharmaceutical Pilot Plant. Undated.
BWC/SP/CONF.III/VEREX/NON. 28	Commercial Confidentiality Concerns Associated with Sampling and analysis During On-Site Inspections Under the BWC. Undated.
BWC/AD HOC GROUP/WP.60	Working paper submitted by Canada - Practice non-challenge visit of a defence research establishment. July 1996
BWC/AD HOC GROUP/WP.76	Working paper submitted by Brazil and the United Kingdom of Great Britain and Northern Ireland - Report of a joint UK/Brazil practice non-challenge visit. July 1996
BWC/AD HOC GROUP/WP.77	Working paper submitted by Australia - Trial inspection of a biological production facility. July 1996
BWC/AD HOC GROUP/WP.173	Working paper submitted by Denmark, Finland, Iceland, Norway and Sweden - Results of a facility declaration trial in the five Nordic countries. July – Aug 1997
BWC/AD HOC GROUP/WP.251	Working paper submitted by the United Kingdom of Great Britain and Northern Ireland - Use of a simulated declaration format in a practice visit. January 1998
BWC/AD HOC GROUP/WP.258	Working paper submitted by the United Kingdom of Great Britain and Northern Ireland - Report of a visit to a pharmaceutical research facility. January 1998
BWC/AD HOC GROUP/WP.298	Working paper submitted by Denmark, Finland, Iceland, Norway; and Corr.1 Sweden - Report of a trial random visit to a biopharmaceutical production facility. Sept. – Oct. 1998
BWC/AD HOC GROUP/WP.310	Working paper submitted by Austria - Report on an international trial random visit, conducted in Austria, August 10-11, 1998
BWC/AD HOC GROUP/WP.345	Working paper submitted by the Islamic Republic of Iran - Report of a national trial visit to a vaccine and serum production facility. January 1999
BWC/AD HOC GROUP/WP.371	Working paper submitted by Switzerland - Report on a trial inspection based on a random visit to a vaccine production facility. June – July 1999
BWC/AD HOC GROUP/WP.398	Working paper submitted by Germany - Report on two trial visits based on a transparency visit concept. Sept. – Oct. 1999

BWC/AD HOC GROUP/WP.414	Working paper submitted by Spain - Report on a trial transparency visit to a biological defensive facility (17 Mar 2000)
BWC/AD HOC GROUP/WP.437	Working paper submitted by Australia - Practice randomly-selected transparency visit to a biodefence facility. Nov. – Dec. 2000

[32] Personal communication, May 2001.

[33] Wayne Biddle, "Proposed Installation Raises Questions and Fears: Just What Germs Would the Army Grow in Utah," *New York Times*, December 16, 1984.

[34] Department of Defense appropriations for 1970. Part 5: Hearings before a Subcommittee of the Committee on Appropriations, US House of Representatives, 91st Congress, 1st Session, Washington, DC, 1969, p. 589.

[35] Pan Zhenqiang, Xia Liping, Wang Zhongchun, eds., *Guoji Caijun yu Junbei Kongzhi*, [International Disarmament and Arms Control], Beijing: Chinese National Defense University Press, December 1996, pp. 52, 182. References 90 and 91 were kindly supplied by Eric Croddy.

[36] Chen Jisheng, "21 Shiji Huasheng Wuqi ji Junkong Fazhan Fenxi" [Analysis of Chemical and Biological Weapons in the 21st Century and Arms Control Developments], *Fanghua Yanjiu*, no. 1, 2000, p. 44.

[37] "Details on Bonn's Bug Warfare Plans," *Democratic German Report*, 17:24 (December 23, 1968), pp. 186-187. The reader who is interested in comparing these charges with descriptions of Germany's defensive BW program in approximately the same period will find several useful sources: the section on "West Germany," pp. 218-219 in Volume II, *CB Weapons Today. The Problem of Chemical and Biological Warfare*, SIPRI, Stockholm: Almqvist & Wiksell, 1971, and Roland Metzner, "The Bundeswehr NBC Defense and Development Institute, " *Military Technology*, #4, 1978, pp. 50-51.

[38] Jan van Aken, "Biologische Waffen: Foschungsprojkete der Bundeswehr," Sunshine Project, June 2001.

[39] "Germany Increases Biological Weapon Defense Funding," *Reuters Medical News*, April 5, 2002.

[40] Personal communication, March 2002.

[41] Jan van Aken and Edward Hammond, "Some Thoughts on Biodefense Research," *INESAP Information Bulletin*, no. 19 (March 2002):11-14.

[42] Dirk Eckert, "Expansion of Defensive Bioweapons Research: The Bundeswehr is Also Using Genetic Engineering," *Hanover Telepolis*, April 10, 2002.

[43] Kathryn Nixdorff and Wolfgang Bender, "Biotechnology, Ethics of Research, and Potential Spin-off," *INESAP Information Bulletin*, no. 19 (March 2002), pp. 19-22.

[44] "Genetic Engineering in German Biodefense Research," Sunshine Project Germany, April 2, 2002.

[45] Andrew Pollack, "Scientists Ponder Limits on Access to Germ Research," *New York Times*, November 27, 2001. William J. Broad, "US Sells Papers on Making Germ Weapons," *New York Times*, January 13, 2002. Scott Lindlaw, "Bush May Censor Germ-Warfare Guides; The US Has Been Selling the Documents, Which Demonstrates How to Manufacture Weapons," *Philadelphia Inquirer*, January 14, 2002. Steven Aftergood, "Do Declassified Bioweapon Documents Pose a Threat," *Secrecy News*, # 6 (January 15, 2002).

[46] William J. Broad, "US is Tightening Rules in Keeping Scientific Secrets, Terrorist Threat Cited; Chemical and Germ Weapons Data Withdrawn – Some Researchers Are Wary," *New York Times*, February 17, 2002; David Enrich, "Extra Care Taken in Declassifying Documents; Pentagon Standards Tougher After Sept. 11," *Washington Post*, March 29, 2002.

[47] *Foreign and Military Intelligence: Book I*, Final Report of the Select Committee to Study Governmental Operations with Respect to Intelligence Activities, US Senate, 94th Congress, 2nd Session, April 1976, pp. 388-389.

[48] *Intelligence Activities: Senate Resolution 21. Volume I: Unauthorized Storage of Toxic Agents*, Hearings Before the Select Committee to Study Governmental Operations with Respect to Intelligence Activities, United States Senate, 94th Congress, 1st Session, September 1975, pp. 1, 189-199.

[49] Rick Weiss and Susan Schmidt, "Capitol Hill Anthrax Matches Army's Stocks. Five Labs Can Trace Spores to Fort Detrick," *Washington Post*, December 16, 2001. It appears that CIA programs in this area have always been pushed aggressively: a notorious and early instance, although not one with international treaty implications, was the 1953 experiments with LSD in project MK:ULTRA that led to the death of a CIA staffer. Ted Cup, "Bad Chemistry: The Haunting Legacy of a CIA Scientist and His Unwitting Victims – Where Patriotism and Madness Meet," *The Washington Post Magazine*, December 16, 2001.

[50] "Statement of Robert E. Waldron, Assistant Deputy Administrator for Nonproliferation Research and Engineering, National Nuclear Security Administration, US Department of Energy, Before the Subcommittee on Emerging Threats and Capabilities, Committee on Armed Services, United States Senate," April 10, 2002.

[51] Dr. Ken Alibek, Testimony to the Joint Economic Committee, US Senate, May 20, 1998.

[52] Personal communication, November 7, 1998, and July 2002.

[53] Personal communication, November 1998.

It is not altogether clear what the rationale behind production of such a molecular genetic "chimera" of two pathogens would have been, as against simply combining the two independent pathogens and delivering them simultaneously. One suggestion has been that it would provide a mechanism to enclose a more lethal but non-contagious pathogen inside the genome of a less lethal but more contagious pathogen to obtain the combination of high contagiousness and high lethality. However, this explanation does not fit the two organisms involved in the alleged case. Another suggestion was to escape disease identification by automated detection and identification devices. However, rapid identification devices did not exist at the time that the supposed "chimera" development took place (and they are only now in development, 15-20 years later). In addition, the strategic rationale that Alibek has described for the potential circumstances in which Soviet military planners conceived of using these agents offered little reason to be concerned with whether the attacked party could identify the disease agent rapidly or not. Nevertheless, as indicated, the project almost certainly did exist.

[54] Sergey Popov, Interview with PBS TV NOVA program "Bioterror," November 17, 2001.

[55] Presentation by Dr. G.W. Korch, NATO Biodefence Conference, Munich, 2002.

[56] B. Moss, "Use of Vaccinia Virus for the Development of Live Vaccines," in *Genetically Altered Viruses and the Environment*, Cold Spring Harbor Laboratory, Cold Spring Harbor, NY, 1985, pp. 291-298;
G. Thomas *et al.*, "Expression and Cell Type-Specific Processing of Human Preproenkephalin with a Vaccinia Recombinant," *Science*, vol. 232 (1986):1641-1643; B. Roizman, and F.J. Jenkins, "Genetic Engineering of Novel Genomes of Large DNA Viruses," *Science*, vol. 229 (1985):1208-1214; Dale Short and Kathleen Blount, "Microscopic Missiles: Revamping Viruses to Demolish Disease," *UAB* (University of Alabama-Birmingham) 22:1 (Winter 2002):3-9; O.I. Serpinski et al., "Design of Orthopoxvirus Recombinant Variants by Foreign Gene Insertion into an Intergene Region of Viral Genome," *Molecular Biology* [Russia], 30:5(1996):1055-1065.

[57] W. Wayt Gibbs, "Bioterrorism: Innocence Lost. Is Enough Being Done to Keep Biotechnology Out of the Wrong Hands?" *Scientific American*, January 2002, pp. 14-15.

[58] A. Lucht et al., "Production of Monoclonal Antibodies to Ebola-Zaire Virus," *Abstracts of the Symposium on Marburg and Ebola Viruses*, October 1-4, 2002, Marburg an der Lahn/Germany, p. 51.

[59] "In Memoriam: Joel M. Dalrymple," p. ix, in *The Microbiologist and Biological Defense Research: Ethics, Politics and International Security*, Annals of the New York Academy of Sciences, ed. Raymond A Zilinskas, vol. 666, 1992, and Laurence K. Altman, "Vaccine for Hanta Virus Found Safe in Early Test," *New York Times*, May 23, 1995.

[60] Severin Carrell, "Porton Down Makes New Plague and Pox," *Independent*, February 10, 2002. "Porton Down" is essentially a misnomer, as there are two separate research establishments at the site – the Centre for Applied Microbiological Research (CAMR) under the U.K. Department of Health, and the Chemical and Biological Defence Sector of DERA (Ministry of Defence, Defence Evaluation and Research Agency) at which most of the work referred to is taking place.

[61] Personal communication, February 2002.

[62] A. M. Bonnet et al., "Recombinant vaccinia viruses protect against Clostridium perfringens a-toxin," *Viral Immunology*, 12 (1991):97-105.

[63] Judith Miller, Stephen Engelberg, and William J. Broad, "US Germ Warfare Research Pushes Treaty Limits: Pentagon Says Projects Are Defensive, and is Pressing Ahead," *New York Times*, September 4, 2001. See also Chapter 12 in *Germs* by Miller, Engelberg, and Broad (2001), pp. 287-299; Vernon Loeb, "US Seeks Duplicate of Russian Anthrax: Microbe to be Used to Check Vaccine," *Washington Post*, September 5, 2001. Since this project was carried out by initiated and professional DTRA or contractor personnel, it would simulate an effort of a small national program. However, according to *Germs*, it was concluded that "a nation *or bioterrorist*" could carry out the project without producing any signature. There is *no* validity to the conclusion that a "bioterrorist" could do what professionals can do. It remains to be seen whether this conclusion will have to be modified if and when the perpetrator(s) of the "Amerithrax" events is identified, as it may turn out to have been by one or more professionals.

[64] Personal communication, 2002.

[65] Judith Miller, "When is Bomb Not a Bomb? Germ Experts Confront US," *New York Times*, September 5, 2001; Elisa D. Harris, "Research Not to be Hidden," *New York Times*, September 6, 2001.

[66] "US Approves Development of Enhanced Anthrax," *Arms Control Today*, 31:9 (November 2001).

[67] Chemical and Biological National Security Program 2000, FY 2000 Annual Report, US Department of Energy, 2000.

[68] "US Declarations Under the BWC CBMs Do Not Mention the US Bio-defense Projects Disclosed by the New York Times on 4 September 2001," SIPRI CBW Forum website, Stockholm, Sweden, September 2001.

[69] Scott Shane, "Anthrax Matches Army Spores," *Baltimore Sun*, December 12, 2001; Scott Shane, "Army Confirms Making Anthrax in Recent Years," *Baltimore Sun*, December 13, 2001.

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[74] "Indian Safeguard Against Nuclear, Biochemical Attack Developed," [Agence France Presse], *The Daily Star* (New Delhi), July 12, 2002; "Indian Scientists Reveal Nuclear, Germ Tests," *Washington Times*, July 13, 2002.

[75] Dr. Anna Johnson-Winegar, Deputy Assistant to the Secretary of Defense for Chemical and Biological Defense, seminar presentation at the National Defense University, Washington, DC, 2001. A Dept. of Defenese workshop that surveyed the state of the art for simulation models of the effects of the release of biological or chemical agents similarly assessed ongoing work in seven areas: intelligence integration and source term; transport, dispersion, fate and terrain; weather (athmospheric dynamics); dose-response; population epidemiology; agriculture and biota; and materiel. Under "transport, dispersion, fate and terrain," it asked, "What happens to the agent after release, through dilution, transformation, deposition, re-suspension, and terrain-related processes?" Precisely the same questions would be asked if the simulations were made in the context of an offensive BW program as in a defensive one. Madhu Beriwal and Peter B. Merkle, Defense Threat Reducation Agency CB Modeling and Simulation Futures Workshop, May 2001.

[76] *Biological Testing Involving Human Subjects by the Department of Defense, 1977*, Hearings before the Committee on Human Resources, United States Senate, 95th Congress, 1st Session, 1977, p. 110.

[77] *Chemical and Biological National Security Program, FY00 Annual Report,* US Department of Energy, pp. 175-177.

[78] *Chemical and Biological National Security Program, FY 00 Annual Report, op. cit.*, pp. 115-117, 123-126.

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[84] Senator Sasser, Letter to Senator Mack Mattingly, Chair of the Senate Appropriations Committee Subcommittee on Military Construction. Cited in Charles Piller and Keith R. Yamamoto, "The US Biological Defense Research Program in the 1980s: A Critique," p. 145, in Susan Wright, ed., *Preventing a Biological Arms Race* (Cambridge, Mass: The MIT Press, 1990.

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[88] R. Jeffrey Smith, "Administration Defends Germ War Test Facility; Critics See Possible Political Repercussions, Question Utility in Developing Defenses," *Washington Post*, May 4, 1988.

[89] Piller and Yamamoto, *Gene Wars, op. cit.*, pp. 129-138. See also Susan Wright, ed., *Preventing a Biological Arms Race, op. cit.*, particularly chapters 5-8. These charges regarding the 1980-1986 US biodefense program were reiterated in April 2002 by Francis Boyle, Professor of International Law at the University of Indiana. He stated that he had read two of the old DOD contracts that had been given to researchers at the University of Indiana, and "They were clearly biological warfare contracts, and the tip-off on any of these contracts is they call for the development in the contract of an aerosol delivery device. That is how biological warfare agents are delivered, by air." Francis A. Boyle, "Faculty Lecture on Bio/Warfare/Terrorism/Weapons," Verbatim Transcript, April 18, 2002.

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[91] Congressman Wayne Owens, testimony inHearings: *Global Spread of Chemical and Biological Weapons*, Committee on Governmental Affairs, US House of Representatives, 101st Congress, 1st Session, May 17, 1989, pp. 181-182.

[92] Dr. Richard H. Ebright, cbw@lists.fas.org, November 21, 2003 and in other communications.

[93] Col. David Huxsoll, Testimony, in Hearings: *Global Spread of Chemical and Biological Weapons*, Committee on Government Affairs, US Senate, 101st Congress, 1st Session, May 1989, pp. 199-203.

[94] Ibid. The diagram appears on p. 522 of the hearing volume.

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[107] See the discussion in Milton Leitenberg, *Biological Weapons Arms Control*, CISSM, Project on Rethinking Arms Control, Paper #16, May 1996, pp. 69-79. The relevant material in that publication is not repeated here.

[108] Personal communication, April 2002.
In the case of three large subjects touched on in previous pages – the Soviet BW program, the Iraqi BW program, and the general subject of verification, inspection, BW site signatures, and so on – I have not repeated material included in earlier publications.

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Black's description of the air filtration and containment features is only partly correct. The equipment had been installed above the ceiling but was not functioning, as Iraq was still attempting to obtain critical components. But the buildings were designed to function in the manner that Black describes.

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