

governmentattic.org

"Rummaging in the government's attic"

Description of document:	Central Intelligence Agency (CIA) document: <u>The Biological and Chemical Warfare Threat</u> , January 1997
Requested date:	01-July-2015
Released date:	02-December-2015
Posted date:	04-January-2016
Source of document:	Freedom of Information Act Request Information and Privacy Coordinator Central Intelligence Agency Washington, D.C. 20505 Fax: 703-613-3007 Filing a FOIA Records Request Online

The governmentattic.org web site ("the site") is noncommercial and free to the public. The site and materials made available on the site, such as this file, are for reference only. The governmentattic.org web site and its principals have made every effort to make this information as complete and as accurate as possible, however, there may be mistakes and omissions, both typographical and in content. The governmentattic.org web site and its principals shall have neither liability nor responsibility to any person or entity with respect to any loss or damage caused, or alleged to have been caused, directly or indirectly, by the information provided on the government agencies using proper legal channels. Each document is identified as to the source. Any concerns about the contents of the site should be directed to the agency originating the document in question. GovernmentAttic.org is not responsible for the contents of documents published on the website.

-- Web site design Copyright 2007 governmentattic.org --



2 December 2015

Reference: F-2015-02095

This is a final response to your 1 July 2015 Freedom of Information Act (FOIA) request for **"a copy of the following six CIA documents:**

- 1. FDD-6440, World Press Treatment of the Use of Gas in Vietnam (translation), May 6, 1965.
- 2. Potential Implications of Trends in World Population, Food Production and Climate, August 1974.
- 3. A Study of Climatological Research as it Pertains to Intelligence Problems, August 1974.
- 4. China: The Coal Industry, November 1976.
- 5. Deception Maxims: Fact and Folklore, April 1980, XD-OSD/NA.
- 6. The Biological and Chemical Warfare Threat, January 1997."

We processed your request in accordance with the FOIA, 5 U.S.C. § 552, as amended, and the CIA Information Act, 50 U.S.C. § 3141, as amended. Our processing included a search for records as described in our 22 July 2015 acceptance letter.

We completed a thorough search for records responsive to your request and located the enclosed three documents, consisting of 114 pages, which we determined are releasable to you in their entirety. Because you are entitled to the first 100 pages free, and the cost for the remaining pages is minimal, in accordance with our regulations, as a matter of administrative discretion, there is no charge for processing your request.

Sincerely,

Michael Javergne

Michael Lavergne Information and Privacy Coordinator

Enclosures

The BIOLOGICAL CHEMICAL Warfare Threat

1997 DC1 NIC

Approved for Release: 2015/10/28 C06464615

Approved for Release: 2015/10/28 C06464615

Contents

		Page
Biological Warfare	: A Tutorial	1
· Intro	duction	1
BW	Agents	1
Prod	uction Processes and Equipment	3
Proc	urement Issues	7
Biol	ogical Weapons Convention	9
Арр	endixes	
A .(Core List of Organisms Having Potential BW Applications	13
В.	Animal Pathogens With Potential BW Applications	14
C.	Warning List	14
D.	General Guidelines for Identifying Dual-Use Biological Equipment and Related Technology	15
E.	Availability Review of Key Dual-Use Bioprocessing Equipment	17

Chemical Warfare: A Tutorial	23
Introduction	23
CW Agents	23
CW Agents and Field Employment	26
Chemical Weapons	28
CW Defense	29
Production of CW Agents	30
Chemical Weapons Convention	32

Ap	De	nđ	ixe	S

F.	Chemical Warfare Agents	34
G.	General Guidelines for Identifying Dual-Use Chemical Equipment and Related Technology	35
H.	CW Agent Precursor Chemicals: Uses and Equivalents	37
l.	CWC Schedules of Chemicals: Guidelines	43
J.	CWC: Schedule 1 Chemicals	44
 Κ.	CWC: Schedule 2 Chemicals	45
 L.	CWC: Schedule 3 Chemicals	46
 M.	Availability Review for Key Dual-Use	47
	Chemical Production Equipment	

	Glossary		
•	Organization and Export Controls	· · · ·	51

iii

The Biological and Chemical Warfare Threat

Biological Warfare: A Tutorial

Introduction

Biological warfare (BW) is the use of pathogens or toxins for military purposes. BW agents are inherently more toxic than chemical warfare (CW) nerve agents on a weight-for-weight basis and can potentially provide broader coverage per pound of payload than CW agents. Moreover, they are potentially more effective because most are naturally occurring pathogens such as bacteria and viruses—which are self-replicating and have specific physiologically targeted effects, whereas nerve agents are manufactured chemicals that disrupt physiological pathways in a general way.

To a country considering a BW program, one advantage of biological weapons over chemical or nuclear weapons is that there are no reliable BW detection devices currently available nor are there any recognizable signals to the human senses. The delay in onset of symptoms could make it difficult to identify the time and place of the attack. Moreover, a BW attack might be readily attributable to a natural outbreak, providing the attacking country with grounds for plausible denial. In addition, biological weapons can be targeted not only against personnel, but also against crops, domestic livestock, and specific kinds of materiel.

Despite their potentially more devastating effects, biological agents have not been used on any significant scale, possibly for a number of reasons. Perhaps for some countries the principal deterrent to the actual use of BW is uncertainty about ultimate consequences. Biological weapons rarely produce instant casualties; and their effects can be uncertain. The risk, for example, of accidentally exposing friendly forces or civilian populations to BW can be dependent on changing meteorological conditions. International outrage muted in the Iraqi CW attacks on Iranians and Kurds—could be much more severe if BW weapons, with their devastating effectiveness, result in massive casualties. Russian President Yel'tsin's 1992 admission that the USSR had an offensive BW program and the discovery of Iraqi BW weapons, programs, and deployments after the Gulf war has increased the urgency with which the worldwide BW problem is regarded. In addition, in 1993 and 1995, some Aum cult members confessed to using anthax and botulinim toxin against targets in Japan, thereby underscoring the grave threat of BW terrorism (see figure 6).

Virtually all the equipment, technology, and materials needed for biological agent production are dual use. Therefore, very little distinguishes a vaccine plant from a BW production facility. The technical skills required to start and run a program are commensurate with basic training in microbiology, and additional knowledge can easily be gained through training courses available from equipment suppliers or scientific meetings. Because of the dual-use nature of BW research and equipment, any BW program could be easily disguised as a legitimate enterprise. For example, known BW threat agents include the organisms that cause anthrax, botulism, tularemia, plague, and Q-fever; because these organisms represent a variety of clinical pathogens, extensive legitimate research is continually under way to eradicate or control them. Medical research or vaccine development, for example, requires production of such organisms on scales varying from laboratory to pilot and industrial levels.

BW Agents

Agents that have been widely recognized as having military utility include pathogens—such as bacteria, viruses, and fungi—as well as toxins. For BW purposes, these agents are incorporated into a munition or some type of dissemination system. The material delivered in the weapon is customarily defined as the BW agent.

I

Examples of Biological Warfare Agents

Disease	Causative Agent	Incubation time (days)	Fatalities (percent)
Anihrax	Bacillus anthracis	1 to 5	80
Plague	Yersinia Pestis	1 to 5	90
Tutarcmia	Francisella tularensis	14 to 10	5 to 20
Cholera	Vibrio cholerae	2 to 5	25 to 50
Venezuelan equine encephalitis	VEE virus	2 to 5	< 1
Q fever	Coxiella burnetti	12 to 21	< 1
Botulism	Clostridium botulinum toxin	3	30
Staphylococcal enterotoxemia (food poisoning)	Staphylococcus enterotoxin type B	1 to 6	<1
Multiple organ toxicity	Trichothecene mycotoxin	Dose dependent	

Pathogens, defined as organisms that cause disease in man, may be grown and exploited for military purposes, as is the case for the bacterial agents that produce anthrax, plague, tularemia, and Q-fever. Other known BW threat agents include viruses—submicroscopic infective agents composed of DNA or RNA that require living cells to replicate. As BW agents, these organisms can produce a wide range of results, with varying degrees of toxicity and time of onset. The route of entry—percutaneous, ingestion, inhalation, parenteral—impacts dramatically on the effective dosage of both BW and CW agents. (For a listing of organisms that could potentially be exploited for BW applications, please see appendixes A through C.)

Alternatively, organisms can be grown to produce toxins that are exploited in weapons, as, for example, *Clostridium botulinum*, a toxin-producing organism that is the causative agent of botulism. Toxins are poisonous compounds produced by living organisms. They are usually proteins that act upon specific receptors in the body. Most are relatively unstable to heat and other traumatic and environmental factors, although some can be separated into smaller fragments that are more stable while retaining toxicity. Toxins can be either lethal or highly incapacitating, with some having potentially greater toxicity than well-known CW agents. Toxins are produced by a variety of organisms, including microbes, snakes, insects, spiders, sea creatures, and plants. One example of a plant toxin is ricin, which is derived from the castor bean. The use of this toxin against two Bulgarian defectors in 1978 in an "umbrella gun" attack underscores another application of BW agents for clandestine or terrorist use. Other examples of toxins having potential application as BW threat agents include tricothecene mycotoxins—derived from fungi—and algal toxins. Algal toxins are suited for BW purposes because of their high toxicity, the lack of vaccines and medical treatment, and the lack of detection systems deployed against them. For example, saxitoxin, produced by marine algae, acts on the nerve cells and ultimately causes respiratory arrest.

A theoretical possibility that should not be discounted for BW threat purposes is exploitation of bioregulators—organic chemicals that regulate cell processes and physiologically active compounds such as catalysts and enzymes. Bioregulators are natural substances produced in very small quantities that are essential for normal physiological functioning of the body. They control cell and body physiological functions and regulate a broad range of functions, such as bronchoconstriction, vasodilation, muscle contraction, blood pressure, heart rate, temperature, and immune responses. These substances can be harmful, however, in large concentrations or if modifications to them bring about changes in the nature and duration of their action. Exploited in such a way for military purposes, they could potentially cause such effects as rapid unconsciousness, heart failure, paralysis, hypotension or hypertension, or psychological disturbances.

Through advanced biotechnical techniques, toxins, bioregulators, and infectious agents are subject to enhancement to increase their utility as BW agents. For example, potential types of genetically engineered disease-causing agents might include antibiotic-resistant bacteria; benign microorganisms genetically altered to produce toxins, venoms, or bioregulators; immunologically altered viruses resistant to standard vaccines and not identifiable by classical scrological means; and bacteria genetically altered to have advanced aerosol and environmental durability.

Production Processes and Equipment

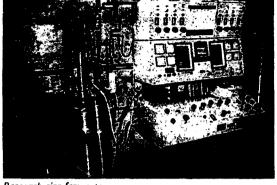
No specialized facilities are required for the production of BW agents, since their production involves dual-use equipment and technologies such as those associated with, for example, a legitimate vaccine or pharmaceutical plant. For biological products, there are three general levels of production—*laboratory scale, pilot scale,* and *industrial scale.* There are no clear demarcations of the vessel sizes for these scales, but they are generally listed as less than 50 liters, 50 to 500 liters, and over 500 liters, respectively.

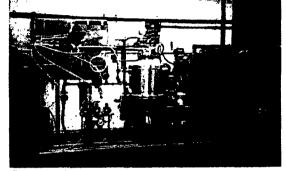
The particular scale of choice depends on the use of the end product. In commercial endeavors such as recombinant insulin production, pilot scale adequately produces enough material, while the production of antibiotics requires much larger industrial-scale volumes. For military applications, pilot scale operations could produce strategically significant quantities of agents, but even laboratory scale operations could, in time, produce enough material for military needs. Genetic engineering offers a great potential for more efficient production of BW agents-especially for those toxin agents that naturally occur in very small quantities. For example, the insertion of DNA that codes for a toxin into a ubiquitous, nonpathogenic organism allows production of significant quantities of that toxin in pilot-scale equipment.

Laboratory scale production is usually limited to research or "bench top" work. It is difficult to distinguish between legitimate commercial and offensive BW research activities because the laboratory equipment is generally the same for both or can be rapidly switched. All the equipment used to research, develop, and produce BW agents is essential for safe and efficient handling of deadly organisms in legitimate biological research. Thus, standard biological laboratory equipment, such as fermenters, large-scale lyophilizers or freeze dryers, class II or III safety hoods, High-Efficiency Particulate Air (HEPA) filters, and centrifuges, could easily be subverted to a weapons program. International attempts are under way to control the sale of this equipment to proliferating countries, although the dual-use nature of the equipment is an inherent problem in identifying BW-related exports (see figure 1).

For research on highly pathogenic organisms, highcontainment or maximum-containment facilities and equipment are generally utilized. The designations P-1/BL-1 through P-4/BL-4 refer to (P)rotection or (B)iocontainment (L)evel, with level 4 being the highest level of protection or containment (see figure 2). Basically, these level designations represent the number of physical barriers that prevent an organism from escaping to the outside from the laboratory work space. By international agreement, P-4/BL-4 is required for work on dangerous agents that pose a high risk of life-threatening diseases. High-containment laboratories (P-4/BL-4) are costly and difficult to maintain; there are only a handful of them around the world, with the majority conducting legitimate research on highly contagious diseases. It should be noted, however, that it is not necessary to have a highcontainment facility for work on BW agents. For example, research of botulinum toxin and anthrax requires only a recommended P-2/BL-2 level of containment. If safety is not a concern to a country, most organisms can be researched at the lowest containment level available.

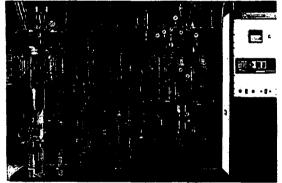
Industrial operations require both pilot- and industrialscale equipment in order to allow the scaleup of research efforts. In general the types of equipment are



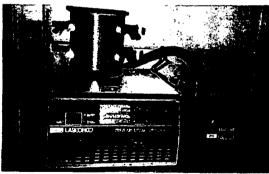


Continuous-flow centrifuge

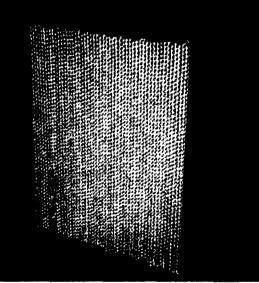
Research-size fermenter



Pilor-scale fermenter



Research-size lyophilizer



HEPA filter

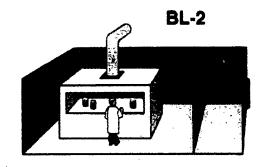


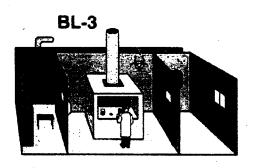
"Space suits" for use in BL-4 suites

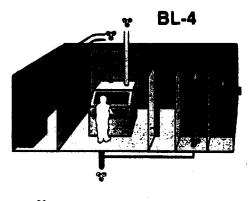
Figure 1



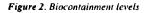
BL-1







8 Sterilization of blohazards



very similar to those used in laboratories, except with increased capacities. Industrial-scale equipment usually has capacities of tens of thousands of liters but may be up to several hundred thousand liters. The limits are usually set by the support apparatus and the availability of raw materials, such as media, and spare parts, such as O-rings and gaskets.

There is no equipment unique to BW agent production, although the Australia Group has defined equipment parameters that would be of particular utility for BW purposes (see appendix D). In the typical biological production process, an organism is grown in a fermenter in a type of media favorable to the organism's growth. While some organisms require very specific nutrients, most can be grown in generic media. Where whole cellular organisms are the desired end product, the cells are subsequently separated from the media in a centrifugal separator and converted to an appropriate form for storage. For botulinum toxin, however, the end product is the toxin that is normally secreted into the media; in this case the cells are separated from the extracellular fluid in a centrifuge and eliminated; the liquids containing the toxin are then purified. Other organisms secrete toxins within the cells; for isolation of these endotoxins, some form of cell wall disruption is necessary before the end product can be isolated.

The Variety and Specifics of Fermentation Processes

In the discontinuous or "batch" process a single batch of nutrients is added to the fermenter. The microorganisms are then inoculated into the nutrient substrate in a process known as charging or seeding. The microorganisms are allowed to grow until the substrate has been exhausted, typically requiring as little as two days. The fermenter volume is commonly larger than that of the other processes in order to more economically exploit the nutrients. Anaerobic or "feed batch" fermentation is carried out in a batch mode in the absence of oxygen. Fresh nutrient is added periodically during production to increase product yields. Usually the product is harvested intermittently. Clostridium botulinum, source of botulinum toxin, and Bacillus anthracis, positive causative organism of anthrax, are organisms grown under anaerobic fermentation conditions.

In continuous fermentation, cells typically are kept in a state of rapid growth as the secreted end products are produced. Additional nutrients are fed into the fermenter at the same rate as the end products are removed so that conditions remain nearly constant. This process increases the overall yield because end product is produced throughout the fermentation process. A significant concern, however, in long-term continuous fermentation is possible contamination by undesirable organisms. This risk is minimized by carefully monitoring the output and terminating the process if contamination is detected.

There are numerous types of fermentation vessels available. A standard, general purpose fermenter consists of a cylindrical metal vessel (usually stainless steel) with a 2:1 height-to-diameter ratio and either a cone-shaped or a sloping bottom to facilitate emptying. The fermenter also has a number of ports for adding nutrients, removing content samples, and inserting control probes. Larger fermenters have integrated steam systems for cleaning and sterilization. The tank may be fitted with openings for venting or collecting waste gases. Most are equipped for agitation by baffle plates fitted inside the fermentation tank and an intermeshing motor-driven impeller. The general types of fermenters include stirred tanks. airlift, chemostatic, cell, immobilized cell (or enzyme), hollow-fiber, and heavy-ton.

The stirred tank and heavy-ton vessels have all the features described above. Heavy-ton, vessels, however, are much larger and are commonly used commercially for Single Cell Protein production-a microbial-based product used for animal feeds. These systems are well suited for most BW agent production. Airlift systems use bubbling air from the bottom of the vessel to stir the broth instead of an agitator. These systems would be well suited for fragile organisms but could not be used in anacrobic fermentation. Chemostatic fermenters are designed to facilitate the continuous fermentation process. The cell, immobilized cell, and hollow-fiber fermenters are designed to provide a small growth surface for the cells by physically separating the cells from the growth media while allowing diffusion of nutrients and end products through membranes. These three allow greater and more efficient yields and are more commonly used with animal cell systems that have greater growth regulation requirements than bacterial cells.

The type of fermentation process depends upon the type of end product desired. The most widely used approaches include discontinuous (batch), anaerobic (feed batch), and continuous fermentation. There is extensive overlap of the volumes among these different processes (see inset and figure 3). Only recently has the technology existed to produce militarily significant quantities of BW agents. Now, virtually any known disease-causing agent can be manufactured in the laboratory, and many can be produced on an industrial scale. With genetic engineering, new possibilities have emerged that could allow

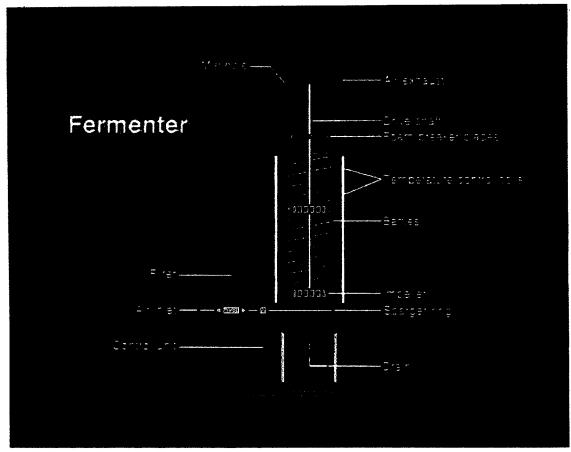


Figure 3. Fermenter

for the design of new pathogens, more virulent strains of organisms, or organisms with characteristics tailored to specific military requirements. With biotechnology and genetic engineering advances since the 1970s, it is now possible theoretically to mass-produce lethal natural products previously available in only small, militarily insignificant quantities. With recombinant DNA technology, for example, it is possible to produce new organisms, exploit variations on organisms, or induce organisms to respond in new ways, such as producing synthetic bioregulators or chemical toxins.

Procurement Issues

International attempts to stem BW proliferation have focused either on suppliers (as the Australia Group is doing—see inset p.31) or on self-disclosures and declarations (under the Biological and Toxin Weapons Convention of 1972). However, supplier responsibilities can be clouded by the dual-use nature of the equipment, and BW developers could claim legitimate defensive research activities or attribute production accidents to naturally occurring epidemics. Both the materials and the technical skills needed to start up a modest offensive BW program are easily attainable and relatively cheap. In general, most organisms needed for a potential offensive BW program are readily available through commercial repositories that isolate, preserve, and distribute cultures. Such repositories can supply thousands of differing bacterial cultures, frozen or freeze-dried, including classical BW agents such as anthrax and Clostridium botulinum. An anthrax culture costs approximately \$45 from a US repository. The current requirement is a signed form accepting responsibility for the receipt and attesting to the existence of adequate facilities and practices to work with potentially highly pathogenic materials. Until very recently, no other verifications were necessary to receive such pathogens. The United States initiated the requirement for end-user certificates on certain pathogenic organisms, but even this measure can be circumvented by otherwise legitimate companies acting on the behalf of BW programs. Starting cultures could also be traded, stolen, or obtained gratis from other research, clinical, or veterinary laboratories or scientists. And finally, any organism may be isolated from the environment.

The equipment and materials needed to produce BW agents, likewise, are easily obtained or can be adapted from readily available items. Virtually any type flask

or useful container can be sterilized in an everyday pressure cooker and used to grow the organism. A 20-liter fermenter combined with a filling port can be obtained from a home brewing supplier for under \$50. These suppliers can also be a source of larger capacity fermenters. Although there are specialized complex media for some of the agents used in BW programs, most agents can be grown in readily available materials. This material may be as simple as augmented animal feeds or easily available milk products. As an aid in determining the potential applicability of materials and equipment to biological agent production, a list of producers of equipment with such potential applications is included as appendix E.

Finally, it should be noted that advances in biotechnology have eliminated the need for a stockpile of BW agents. Proliferating nations need only a starter culture of agent; they can then wait until they wish to use biological weapons to produce the quantities required. In contrast to a CW program, for example, there is no need in BW efforts for a continuing supply of sizable quantities of precursor chemicals and raw materials.

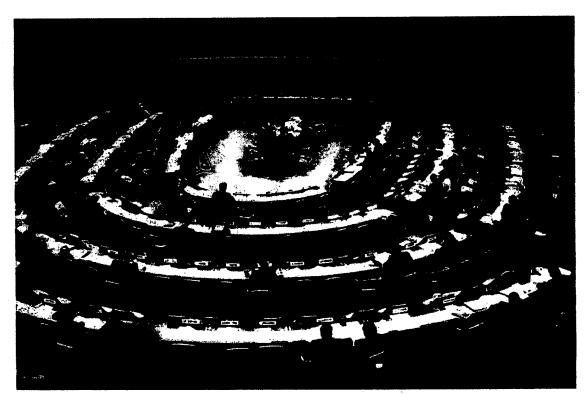


Figure 4. BWC assembly

Biological Weapons Convention

On April 10, 1972, the Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (BWC) was opened for signature. Since it entered into force on March 26, 1975, the BWC has been signed and ratified by 140 countries, signed but not ratified by 18 countries, and observed by the Government of Taiwan (see figure 5).¹

The BWC prohibits the development, production, stockpiling, or acquisition of microbial or other biological agents or toxins of types and in quantities that have no justification for prophylactic, protective, or other peaceful purposes. The BWC also prohibits the weapons, equipment, or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict. It also requires that each State Party destroy, or to divert to peaceful purposes, all agents, toxins, weapons, equipment, and means of delivery which are in its possession or under its jurisdiction or control. Each State Party also agrees not to transfer any of the agents, toxins, weapons, equipment, or means of delivery to any recipient and not to assist, encourage, or induce any State to manufacture or otherwise acquire such organisms or equipment for nonpeaceful purposes.

The BWC has no verification provisions, and there are significant difficulties in determining the existence or status of BW programs. Advances in biology may

Q

¹ Effective January 1, 1979, the United States recognized the Peoples Republic of China as the sole legal government of China. The authorities of Taiwan then stated that they would continue to abide by the provisions of the BWC, and the United States regards them as bound by its obligations.

Figure 5

Status of the Biological Weapons Convention as of 1 May 1997



States Parties (140)

Afghanistan Dominicai Libya Dominican Republic Albania Argentina Ecuador El Salvador Armenia Estonia Australia Austria **Equatorial Guinea** Malaysia Maldives Ethiopia The Bahamas Maita Bahrain Fiji Finland Mauritius Bangladesh Mexico France Barbados Mongolia Belarus The Gambia Belgium Georgia Belize Germany Ghana Benin Bhutan Greece Niger Nigeria **Bolivia** Grenada Boshia and Herzegovina Guatemala Norway Guinea-Bissau Botswana Honduras Oman Brazil Pakistan Hungary Brunei iceland Panama **Bulgane** India **Burkina Faso** Paraguay Indonesia Cambodia Iran Peru Canada iraq Cape Verde Ireland Poland Chile Italy Portugal China Jamaica Qatar Colombia Romania Japan Congo Jordan Russia Costa Rica Kenya Rwanda Croatia Kuwait Cuba Laos St. Lucia Cyprus Latvia Czech Republic Lebanon Denmark Principe Lesotho

Liechtenstein Luxembourg The Former Yügoslav Republic of Macedonia Malaysia Maldves Maita Mauritus Mexico Mongolia Netherlands New Zealand Nicaragua Niger Nigeria Norway North Korea Oman Pakistan Panama Papua New Guinea Paraguay Peru Philiopines Poland Portugal Qatar Romania Russia Rwanda St. Kitts and Nevis St. Lucia San Marino Sao Tome and Principe Saudi Arabia Senegal Serbia and Montenegro Seveneties Sierra Leone Singapore Slovakia Slovenia Solomon Islands South Africa South Korea Spain Sri Lanka Suriname Swaziland Sweden Switzerland Thailand Togo Tonga Tunisia Turkey Turkmenistan Uganda Ukraine United Kingdom **United States** Uruguay Uzbekistan Vanuatu Venezuela Vietnam Yemen Zaire Zimbabwe

Signatories (18)

Burma Burundi Central African Republic Cote d'Ivoire Egypt Gabon Guyana Haiti Liberia Madagascar Malawi Mali Morocco Nepal Somalia Syria Tanzania United Arab Emirates

Observer

Taiwan

have made the requirement for stockpiling obsolete and may have increased the number of possible BW agents since the Convention entered into force in 1975. In order for a program to violate the BWC, it must be established that the program cannot be justified for prophylactic, protective, or other peaceful purposes.

States Parties attending the second BWC Review Conference in 1986, concerned about the lack of verification provisions, adopted a set of non legally binding confidence-building measures (CBMs), which were expanded at the Third Review Conference in 1991. States Parties voluntarily submit annual data declarations to the United Nations by April 15, regarding information that could be associated with BW programs. These include information concerning:

- Research centers and laboratories with maximum biocontainment capability.
- National biological defense research and development programs.
- · Outbreaks of infectious diseases.
- National legislature and regulations.
- Past activities in offensive and/or defensive biological research and development programs.
- Vaccine production facilities and types of diseases covered.

As participation in the CBM process has been less than universal, States Parties agreed to consider measures to further strengthen the BWC. The Special Conference held in September 1994 mandated the convening of an Ad Hoc Group to draft a legally binding instrument designed to provide increased transparency of activities and facilities that could have biological weapons applications to help deter violations of and enhance compliance with the Convention. The Ad Hoc Group held one organizational and four substantive sessions between its establishment in January 1995 and the Fourth Review Conference in November 1996. Topics under discussion include:

- Measures to promote compliance, such as challenge visits to facilities whose activities are suspected to be in violation of Article I, and mandatory annual data declarations.
- Definitions of terms and objective criteria relevant to specific measures, such as lists of bacteriological (biological) agents, toxins, and relevant equipment.
- Assistance for the peaceful transfer of biotechnology.

Such measures would be formulated and implemented in a manner designed to protect sensitive proprietary information and legitimate national security needs while avoiding any negative impact on scientific research, international cooperation, and industrial development. The Ad Hoc Group will meet at least for three 3-week sessions in 1997; the United States is aiming for a 1998 target date for completion of the work of the Ad Hoc Group.

Appendix A

Core List of Organisms Having Potential BW Applications

Viruses

Chikungunya virus Congo-Crimean haemorrhagic fever virus Dengue fever virus Eastern equine encephalitis virus Ebola virus Hantaan virus Junin virus Lassa fever virus Lymphocytic choriomeningitis virus Machupo virus Marburg virus Monkey pox virus Rift Valley fever virus Tick-borne encephalitis virus (Russian Spring-Summer encephalitis virus) Variola virus Venequelan equine encephalitis virus White pox Yellow fever virus Japanese encephalitis virus Rickettsiae Coxiella burnetii Rickettsia quintana Rickettsia prowasecki Rickettsia rickettsii Bacteria **Bacillus** anthracis Brucella abortus Brucella melitensis Brucella suis Chlamydia psittaci Clostridium botulinum Francisella tularensis Pseudomonas mallei Pseudomonas pseudomallei Salmonella typhi Shigella dysenteriae Vibrio cholerae Yersinia Pestis

Genetically Modified Micro-Organisms

Those micro-organisms that contain nucleic acid sequences associated with pathogenicity and are derived from organisms in the core list.

Those micro-organisms that contain nucleic acid sequences coding for any of the toxins in the core list.

Toxins

Botulinum toxins Clostridium perfringens toxins Conotoxin Ricin Saxitoxin Shiga toxin Staphylococcus aureus toxins Tetrodotoxin Verotoxin Microcystin (Cyanginosin)

Appendix **B**

Animal Pathogens With Potential BW Applications

Viruses

African swine fever virus Avian influenza virus (only those of high pathogenicity) Bluetongue virus Foot and mouth disease virus Goat pox virus Herpes virus (Aujeszky's disease) Hog cholera virus Lyssa virus Newcastle disease virus Peste des petits ruminants virus Porcine enterovirus type-9 **Rinderpest virus** Sheep pox virus Teschen disease virus Vesicular stomatitis virus

Bacteria Mycoplasma mycoides

Genetically Modified Micro-Organisms

Genetically modified micro-organisms or genetic elements that contain nucleic acid sequences associated with pathogenicity and are derived from organisms in the core list.

Appendix C

Warning List

Viruses

Kyasanur Forest virus Louping ill virus Murray Valley encephalitis virus Omsk hemorrahagic fever virus Oropouche virus Powassan virus Rocio virus St. Louis encephalitis virus

Bacteria

Clostridium perfringens Clostridium tetani Enterohaemorrhagic Escherichia coli serotype 0157 and other verotoxin producing serotypes Legionella pneumophila Yersinia pseudotuberculosis

Genetically Modified Micro-Organisms

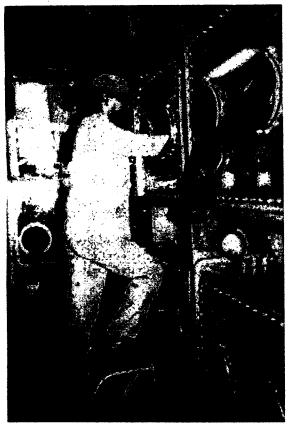
Genetically modified micro-organisms or genetic elements that contain nucleic acid sequences associated with pathogenicity and are derived from organisms in the warning list.

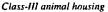
Genetically modified micro-organisms or genetic elements that contain nucleic acid sequences coding for any of the toxins in the warning list.

Toxins Abrin Cholera toxin Tetanus toxin Trichothecene mycotoxins

Appendix D

General Guidelines for Identifing Dual-Use Biological Equipment and Related Technology





Complete Containment Facilities at P3/BL3, P4/BL4 Containment Level

Complete containment facilities that meet the criteria for P3 or P4 (BL3, BL4, L3, L4) containment (as specified in the WHO Laboratory Biosafety Manual).

Fermenters

Capacity equal to or greater than 300 liters (L).



Double-walled aerosol chamber

Made of polished stainless steel, borosilicate glass, polished aluminum (or plastic/other noncorrodible material).

Double or multiple sealing joints within the steam containment area.

Capable of in situ sterilization in a closed state.

Centrifugal Separators

Flow rate greater than 100 L per hour.

Components of polished stainless steel or titanium.

Double or multiple scaling joints within the steam containment area.

Capable of in situ steam sterilization in a closed state.

Freeze Drying Equipment

Steam sterilizable freeze drying equipment with a condensor capacity greater than 50 kg of ice in 24 hours and less than 1,000 kg of ice in 24 hours.

Cross-Flow Filtration Equipment

Cross-flow filtration equipment designed for continuous separation of pathogenic microorganisms, viruses, toxins, and cell cultures without the propagation of aerosols, having all the following characteristics:

- Equal to or greater than 5 square meters.
- Capable of in situ sterilization.

Equipment That Incorporates or Is Contained in P3 or P4 Containment Housing Specifically:

Independently ventilated protective full or half suits.

• Class-III safety cabinets or isolators with similar performance standards.

Aerosol Inhalation Chambers

Chambers designed for aerosol challenge testing with pathogenic microorganisms, viruses, or toxins and having a capacity of 1 cubic meter or greater.

Other Equipment

Equipment for the microencapsulation of live microorganisms and toxins in the range of 1 to 10 meters particle size, specifically:

Interfacial polycondensors.

• Phase separators.

Fermenters of less than 300-liter capacity with special emphasis on aggregate orders or designs for use in combined systems.

Conventional or turbulent air-flow clean-air rooms and self-contained fan-HEPA filter units that may be used for P3 or P4 (BL3, BL4, L3, L4) containment facilities.

Appendix E

Availability Review of Key Dual-Use Bioprocessing Equipment

Confirmed sources (manufacturers capable of producing ermenters of 100 liters or greater)		Non-Australia Group	Manufacturer
		Brazil	Sulzer do Brasil SA Industria e Comercio
Australia Group Australia	Manufacturer B Braun Australia Pty, Ltd.	Bulgaria	Scientific Research Lab for Instrument Making and the Automation of Biological Experiments
Australia .		Czech Republic	Kralovopolska Stroyirna
Austria	Sulzer Australia Pty, Ltd. Andritz Maschinenfabrik AG	and Slovakia	······
Belgium	Sulzer Belgium SA/NV	Russia and the	All-Union Scientific Research Design Institute
Canada	Pegasus Industrial Specialties, Ltd.	other newly inde- pendent republics	of Applied Biochemistry
Culledo	Sulzer Canada, Inc.	pendent republies	Institute of the Biochemistry and Physiology o Micro-Organisms
	WHE Process Systems, Ltd.		Irkutsk Scientific Research Institute of Chemi-
Denmark	Alfa-Laval AS		cal Machines
France	Chemap (made in Switzerland)		NPO Biopribor
France	Inceltech		NPO Biotekhnika
	LSL Biolafitte SA		Special Design Bureau for Biological Instru-
	SGi Setric Genie Industriel		ments
<u></u>		South Korea	Korean Fermentor Co.
Germany	Alfa-Laval Industric GmbH B Braun Diessel Biotech GmbH	Unconfirmed sou	rces
	Chemap GmbH (made in Switzerland)	Australia Group Australia	Manufacturer
	New Brunswick Scientific GmbH (made in US)		Bulkon Australia Pty, Ltd.
	Sulzer-Escher Wyss GmbH		Cawthron Institute
Hungary	Vegyepszer	Austria	Arge Biotechnologic
Italy	Alfa-Laval SpA		Raiffeisen-Bioforschung
	B Braun Milano SpA (made in Germany)		Vogelbusch
Japan	B Braun Biotech Co., Ltd. (made in Germany and Malaysia)	Belgium	Belgolab SA
	Marubishi Bioengineering Co., Ltd.		Biotim NV
	Mitsuwa Rikagaku Kogyo Co., Ltd.		Elscotab NV
Netherlands	Applikon Dependable Instruments BV		Holurieka NV
	Sulzer Nederland BV		Microgon, Inc.
Sweden	Chemoferm AB	Canada	Mueller Canada, Inc.
	Electrolux Fermentation		The SNC Group
Switzerland	Bioengincering AG		St. Lawrence Reactors, Ltd.
	Chemap AG		Techneurop, Inc.
	LSL Secfroid SA	······	Wardrop Engineering, Inc.
	MBR Bio Reactor AG	Finland	G. W. Berg & Co., AB
United Kingdom	B Braun Medical, Ltd.		Rintekno OY
U	Bioengineering UK, Ltd.	France	Bertin & Cie
	Centech, Ltd.		Bignier Schmid Laurent
	FT Applikon, Ltd		Biolog
	LH Fermentation, Ltd.		BSL Industries SA
	Life Sciences Laboratories, Ltd.		ССМ
	MBR Bio Reactor (UK), Ltd.		Cellier SA
	Sulzer (UK). Ltd.		

I

Appendix E

Availability Review of Key Dual-Use Bioprocessing Equipment (continued)

France (continued)	Flobio	Japan	Nippon Kokaan K.K.
	Goavec	(continued)	Nisshin Oil Mills, Ltd.
	Interscience		Yakult Honsha Co., Ltd.
	Lequeux	Netherlands	Amsterdam Valve & Fitting BV
	Pharmacia LKB Instruments SA		APV Nederland BV
	Sonertec		Bert Versteeg-Veetech BV
Germany	Aluminiumgiesserei Neukoelin Oskar		Contact Flow
	Waltersdorf GmbH		Dalton BV
	Atlantik Geractebau GmbH		Holurieka Holding BV
	Bioinvest Engineering		Lameris Laboratorium
	Buero Biotechnik		Marius Instruments
	Deutsche Metrohm GmbH & Co.		Netherlands Institute for Dairy Research
	Diessel GmbH & Co.		Pharmacia Nederland BV
	Fr Kammerer GmbH		Rhone Poulenc Nederland BV
	Friedrich & Hofmann		Salm & Kipp
	Heinrich Frings GmbH		Vogelaar Electronics
	Holag Technologie AG	Spain	CETS Institut Químico de Sarria
	Holurieka GmbH	Sweden Switzerland United Kingdom	Knoik Instruments SA
	IBL GmbH		Biolink
	ІМА Ствн		Ninolab AB
	Kalger GmbH		Amicon Division
	KC Biological		Arbeitsgemeinschaft Bioenergie
	Kraftanlangen Heidelberg AG		Lonza, Ltd.
	Lang Labortechnik		Rosenmund AG
	Membran-Tecknik-Hamburg		Alcon Biotechnology, Ltd.
	PRG Praaezisions-Ruehrer GmbH		Alfa-Laval Engincering, Ltd.
	Schuett Labortechnik GmbH		Anglicon Instruments, Ltd.
	Siemens AG		APV Baker
	Then Maschinen un Apparatebau GmbH		APV Barnetta Rolfe, Ltd.
	VEB Chemieanlagenbaukombinat		B & P Biotechnology, Ltd.
Hungary	Mafki Ungar, Erdoel-und Erdgas Forschungin-		BS Flocor, Ltd.
	stitut		Catalytic International, Inc.
	Magyar Tudomanyos Akademia		Charles River UK, Ltd.
Ireland	P J Brennan & Co., Ltd.		Chemquip, Ltd.
Italy	A Biotec		Dulas Engineering, Ltd.
	Olsa SpA		ECC International, Ltd.
	Oxytek SAS		Endotronics
- H	Visniara Associates SpA		Fairey Engineering, Ltd.
lapan	Fuji Electric Co.		GB Biotechnology, Ltd.
	Hirayama Manufacturing Corp.		Henfrey Engineering
	Hitachi, Ltd.		Hickey & Co., Ltd.
	Idemitsu Kosan Co.		Imperial Biotechnology, Ltd.
	Kawasaki Heavy Industries		Life Technologies, Inc.
	Mitsubishi Heavy Industries		

Approved for Release: 2015/10/28 C06464615

Appendix E

Availability Review of Key Dual-Use Bioprocessing Equipment (continued)

United Kingdom	Lummus Crest, Ltd.		
4	MacLeod & Miller (Engineers), Ltd.	Australia Group	Manufacturer
	Mass Transfer International	Australia	Beckman Instruments Pty. Ltd.
	Matthew Hall Engineering, Ltd.	Austria	Heraeus Wien
	National Engineering Laboratory		Westfalia Separator Austria GmbH
	NEBC Developments	Denmark	6V Separation AS
	Penrhos Electronics		Alfa-Laval Separation AS
	Pharmacia-LKB Biochrom, Ltd.	France	Alfa-Laval SA
	Roth Scientific Co., Ltd.		Beckman
	Schaefer Instruments, Ltd.		Dupont de Nemours SA
	SGi (UK), Ltd.		Jouan SA
	Techmation, Ltd.	Germany	Alfa-Laval Industrietechnik GmbH
	TechnoGen Systems, Ltd.	•	Heraeus-Christ Separationstechnik GmbH
	Titanium Fabricators, Ltd.		Heracus-Sepatech GmbH
•••••••	Thailium Pabricators, E.G.		Kontron Instruments GmbH
Non-Australia	Manufacturer	Italy	Alfa-Laval SpA
Group		•	Beckman Analytical SpA
Brazil	Biobas		Dupont de Nemours Italiana SpA
	Centro de Technologia Promon	Japan	Alfa Laval K.K.
	CESHMT Com & Repr, Ltd.a	Netherlands	Labineo BV
	Codistil	÷	Lameris Laboratorium
	Coperucar	Norway	Heigar & Co. AS
	Dedini SA		Nyegaard & Co. AS
	Faculdade de Engenharia Industrial	Sweden	Bergman & Beving AB
	Setal Instalações Industrias SA	Switzerland	Alfa-Laval Industriegesellschaft AG
	TECHPAR		Dr. Bender & Dr. Hobein AG
	Zanini SA Equipmentos		Heraeus AG
Czech Republic	Kovodruzhstvo		LSL Secfroid SA
and Slovakia	Microbiology Institute of the Czechoslovakia		Treff AG
	Academy of Sciences	United Kingdom	A.R. Horwell, Ltd.
	Yednoine Zemyedyelske Druzhestvo Rude Armady		Alfa-Laval Engincering, Ltd.
China	Beijing Institute of Chemical Metallurgy		APV Chemical Machinery, Ltd.
Cilita	Dalian Institute of Chemical Physics		Baird & Tatlock, Ltd.
Russia and the	All-Union Scientific Research Biotechnology		Burkard Scientific, Ltd.
other newly inde-			Camlab, Ltd.
pendent republics	Livani Biochemical Plant		Centrilab
	Shebekino Biochemical Plant		Damon/IEC, Ltd.
South Korea	Doosan Manufacturing Co.		Denley Instruments, Ltd.
(Former)	Livani Biochemical Plant		Dupont (UK), Ltd.
Yugoslavia	Shebekino Biochemical Plant		Eltex of Sweden, Ltd.
2. Worldwide ma	nufacturers of centrifugal separators		Hawksley & Sons. Ltd.
	icturers of centrifugal separators		Jouan, Ltd.

. 19

$\label{eq:Appendix} \textbf{Appendix} ~ \textbf{E}$

Availability Review of Key Dual-Use Bioprocessing Equipment (continued)

United Kingdom	MSE	Russia	Moscow Production Institute of the Food
(continued)	MSE Scientific Instruments		Industry
	Nycomed, Ltd.		All-Union Scientific Research and Experimen- tal Design Institute of the Food Machine Build
	Nygaard (UK), Ltd.	South Korea	ing Industry
	Sarstedt, Ltd.		Han Seong Machinery Manufacturing Co.
	Simsons of Edinburgh, Ltd.		Korea Storage Battery Co.
	V. A. Howe & Co., Ltd.	Taiwan	Bestway Corp.
	Zeta Engineering, Ltd.	,	Chang Jung Business Company, Ltd.
Other worldwide	manufacturers of centrifugal separators		Sui Sheng Refrigeration Engineering Co.
			Yau Yuan Industrial Machinery Co.
	Manufacturer	Ukraine	Kharkov Institute of Mechanization and Elec-
Belgium	Sanki Engineering, Ltd.		trification of Agriculture
	Sweco Europe SA	Other countries	
Canada	Sarstedt Canada, Inc.		e Republic of South Africa possess the techno-
Finland	Finn Metric OY		, industrial capability, and supporting infrastruc-
France	Guinard Centrifugation		e most advanced centrifuges. India, Brazil, and potential producers.
	Kontron		nufacturers of freeze dryers
	NEN France Sarl		es (manufacturers capable of producing units
	Rousselot Ets		per batch capacity)
Germany	AMKO Light Technology Instruments GmbH		
	Andreas Hettich	Australia Group	Manufacturer
	Berthold Hermle GmbH	Finland	Finn-Acqua Corp. (owned by AMSCO)
	Carl Padberg Zentrifgenbau GmbH	France	Cellier
	Electro-Nucleonics International, Ltd.		CIRP/Serail
	Eppendorf-Netheler-Hinz GmbH		Uifroid S. A.
	Hettich-Zentrifugen	Germany	Leybold-Heracus GmbH (owned by AMSCO)
	Industrienlagen AG	United Kingdom	Edwards High Vacuum Intl. (British Oxygen)
	Wimmer GmbH		(owned by AMSCO)
	Zirbus-Verfahrenstechnik	Non-Australia	
Italy	Hewlett Packard Italian SpA	Group	·
Japan	Fuji Filter Manufacturing Co., Ltd.	None identified	
	Hitachi Koki Co., Ltd.	Unconfirmed sou	Irces
	Mitsubishi Kakoki Kaisha, Ltd.	Australia Crous	Manufacturer
	Nippon Atomic Industry Group Co.	Australia Group Austria	Labin
	Shinmaru Enterprises Corp.	Ausina	
Netherlands	Amsterdam Valve & Fitting BV	Denmark	Reichert-Jung
	Pijttersen BV	Dennark	Atlas (manufactures automated tray loading freeze dryers for the food industry)
Portugal	Elnor	France	Biolafitte
Spain	Hucoa-Erloss SA		Froilabo Biomedical
Non-Australia Group	Manufacturer		Group S.G.D.
Malaysia	Juru Rubcoil Sdn Bhd		Heraeus
			Hibbon International
			Rua Instruments

Appendix E

Availability Review of Key Dual-Use Bioprocessing Equipment (continued)

Germany	Alb. Klein GmbH	These items may not be commercially available, although aerosol			
	Martin Christ GmbH & Co., K.G.	generators commonly used in the agriculture industry to dissemi- nate biological and chemical pesticides may be capable of dissem			
	Polimex	nating BW agents.			
Italy	Edvards Alto Vuoto	5. Equipment for the microencapsulation of live micro-organ-			
Japan	Osaka Gas	isms			
Netherlands	Grenco BV	Equipment used for microencapsulation of live micro-organisms			
Portugal	Cassel Industrias	available worldwide. Although the process known as coacervation			
Spain	Telstar S.A.	 was patented over 30 years ago, certain specialized equipment and technical know-how appear to be the most critical aspects of this 			
Switzerland	Salvis	item.			
United Kingdom	Tech	6. Biohazard containment equipment, as follows: (a) complete			
Non-Australia Group	Manufacturer	BL-3 or BL-4 level laboratory facilities, (b) equipment or com- ponents intended for the construction of such facilities			
India	Aircons Pvt., Ltd.	Equipment as described in this item is available within and outside			
	Coil Company, Ltd.	the AG countries, including sources in China and Taiwan. Foreign manufacturers of this equipment include:			
	Ice-King Refrigeration Engineering	7. Detection or assay systems for biological agents or toxins,			
	Ice & Diesel Engineering Works	capable of detecting concentrations less than one part per mil-			
	Super Refrigeration, Ltd.	lion in air			
Israel	Polipach, Ltd.	Based on published information, the German multinational firm			
Malaysia	Juru Rubcoil Sdn Bhd	 Dracger Akritngesellschaft appears to be the only manufacturer of this item. Dracger is considered a world leader in the production of 			
Poland	Polimex-Cekop	sensitive devices for monitoring toxic substances. In addition to its			
China	Changchun Pneumatic Components	Luebeck-based firm, Draeger has production and distribution facil			
Singapore	Associated Instrument Mfg. (S), Ltd.	ities located throughout the world, including distribution facilities in Toronto, Canada, and Pittsburgh, Pennsylvania.			
	O.S.L. Sinko	8. Complex media for the growth of micro-organisms in Class 3			
Taiwan	Bestway Corp.	or Class 4, in quantities greater than 100 kilograms, specially			
	Chang Jung Business Co., Ltd.	brain/heart infusion media			
	Fu Sheng Ind Co., Ltd.	The material described in this item typically consists of a base of			
	Sui Sheng Refrigeration Eng. Co.	soybean milk or dry milk casein powder infused with a broth of the organs from animals. Russia and the other newly independent			
	Yau Yuan Ind Machinery Co., Ltd.	republics and Cuba possess the technology to commercially pro-			
Russia and the other newly inde- pendent republics		duce such media, which is also available from Germany and the United Kingdom.			
	ators specially designed to disseminate live				

Chemical Warfare: A Tutorial

Introduction

Chemical warfare (CW) can be considered the military use of toxic substances such that the chemical effects of these substances on exposed personnel result in incapacitation or death. It is the impact of chemical effects instead of physical effects (such as blast and heat) that distinguishes chemical weapons from conventional weapons, even though both contain chemicals. In many cases in the Third World, there can be considerable confusion as to what is a chemical weapon and what is not. Some countries consider smoke, flame, incendiary, or riot control weapons to be chemical weapons and label them as such; in addition, conventional weapons can inflict casualties resembling those caused by chemical weapons.

Generally speaking, a chemical weapon comprises two main parts: the agent and a means to deliver it. Optimally, the delivery system disseminates the agent—most often a liquid—as a cloud of fine droplets, known as an aerosol. This permits the highly toxic agents to cover a relatively broad amount of territory evenly and efficiently.

Chemical warfare, as we know it, began in 1915 when Germany disseminated large clouds of chlorine, a choking agent, on French troops. Allied forces eventually responded in kind, resulting in continuous escalation by both sides until the end of the war. By the time the Armistice was signed in November 1918, well over 1 million soldiers and civilians had been injured by chemical weapons, and nearly 100,000 had died. Chemical weapons continued to be used sporadically after World War I-including Italian use in Ethiopia in 1937 and Egyptian use in Yemen during the mid-1960s-but large-scale use of chemical weapons did not resume until Iraq began using them against Iran in 1983. It was this use that underscored the threat of CW proliferation among Third World countries and highlighted the need to control the spread of chemical weapons. Even more disturbing is the chemical weapons threat from terrorist organizations. The terrorist incident staged on March 20, 1995 by the Japanese

cult Aum Shinrikyo demonstrated that the use of CW is no longer restricted to the battlefield (see figure 6).

CW Agents

Chemical warfare agents (see appendix F) can be classified on the basis of a number of physical and chemical properties. These properties, which underlie the advantages and disadvantages of each agent, are summarized below.

Lethality is a way of classifying CW agents to be either lethal or nonlethal, but there is not always a clear distinction. Lethal agents are designed primarily to cause fatalities under battlefield conditions, although sublethal doses will cause incapacitation. Nonlethal agents are designed primarily to incapacitate or injure but can kill in large enough doses.

Mode of action indicates by which of several routes CW agents and other toxic chemicals affect living organisms. From a CW standpoint, the most useful routes of exposure are passive ones, such as inhalation and percutaneous means. An agent that acts via inhalation damages the lungs or passes rapidly into the bloodstream when breathed in, while an agent that acts percutaneously damages (or enters the body through) the skin, eyes, or mucous membranes. Less useful on the battlefield but still valid for terrorist purposes are poisons that act orally—by damaging the digestive system or passing into the bloodstream when swallowed—and intravenously, by passing directly into the bloodstream.

Speed of action is a measure of the delay between exposure and effect. Rapid-acting agents can cause symptoms to appear almost instantaneously and might cause fatalities in as little as a few minutes. Slow-acting agents can take days before causing the first symptoms and might take weeks or months before fatalities occur. In general, though, higher doses increase the rate of action.

Aum Shinrikyo

Acupuncturist Chuizuo Matsumoto, better known as Shoko Asahara, founded the group Aum Shinrikyo, or Aum Supreme Truth, in the early 1980s. Licensed in Japan as a religious organization in 1989, Aum was one of thousands of similarly registered groups, many of which claimed to offer spiritual refuge for Japanese alienated by their country's materialism. Aum promoted a version of Tibetan-style mysticism and promised extrasensory experiences as a path to enlightenment.

Asahara soon revealed his desire for political power. In the fall of 1989 he declared his intent to become "a spiritual dictator, a dictator of the world," according to Japanese press reports. In 1990, Asahara and 24 members of Aum campaigned for seats in the Lower Diet (parliament) but failed to win seats. Subsequently, Asahara began to presage a final cataclysmic war using nuclear and chemical weapons between Japan and the United States that would take place in 1997.

Press reports speculate that Aum's chemical attack in Tokyo on March 20, 1995 was aimed at the Japanese National Police Agency (NPA) in an attempt to stop impending raids on the cult's facilities by creating panic throughout Japan.

Aum targeted the three Tokyo subway lines—Hibiya, Marounouchi, and Chiyoda—that pass through the Kasumigaseki station and service the major concentration of government ministries and the NPA (see figure 6). At the height of morning rush hour, 11 plastic bags wrapped in newspaper were punctured with sharp objects, such as umbrella tips, as the perpetrators left the trains. Statements from witnesses reported by the press indicated that the attackers were dressed in "normal" street garb—business suits, sunglasses, and surgical-type masks, which are common on the streets of Tokyo.

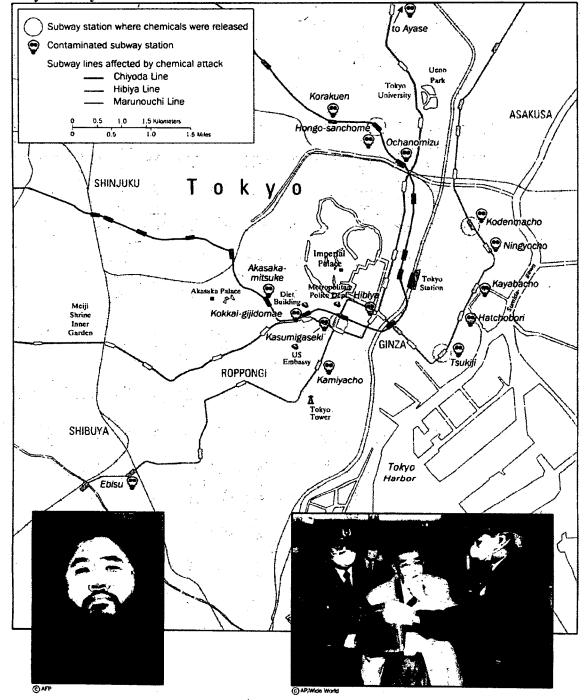
In all, 15 subway stations and three train lines were affected by the dispersal of the chemicals. Twelve people died, and approximately 5,500 people required medical treatment, with the highest number of casualties at the Kasumigaseki, Hibiya, and Tsukiji stations.

Japanese authorities determined that Aum had produced the chemical nerve agents sarin and VX. Further probing after the March 1995 attack indicates that this was not the first or last use of chemical or biological agents by the cult. In all, the cult appears to have conducted at least 2 biological attacks with anthrax and botulinum toxin and 5 chemical attacks with sarin and cyanide, including the Tokyo subway attack. These attacks met with varying success.

The Aum was able to legitimately obtain all of the components it needed to build its sizable chemical and biological infrastructures. However, terrorists and violent sub-national groups need not acquire the massive infrastructure of the Aum. Only small quantities of precursors, available on the open market, are needed to manufacture deadly chemical and biological weapons for terrorist acts.

Toxicity is a measure of the quantity of a substance required to achieve a given effect. CW agents are really just highly toxic compounds that work via inhalation or skin contact. For example, 3,200 milligrams (mg) of the World War I choking agent phosgene per cubic meter of air will kill 50 percent of a test population of humans breathing this mixture. Only 70 mg of the nerve agent sarin—only 2 percent of the amount of phosgene—is required to cause the same fatality rate. The nerve agent VX is even more toxic; just 10 mg on the skin will kill the average adult male. One gallon (3.785 liters) of VX contains 362,000 such doses. By

Figure 6 Tokyo Subway Chemical Incident



definition, if the VX is evenly applied at this dosage, 50 percent—or 181,000 people—will die as a result, with the remaining 181,000 becoming seriously ill. This is not really a practical example because, in battlefield use, it is impossible to apply such precise dosages; only a small part of the agent comes into contact with victims. Therefore, such a high casualty rate will never be achieved in practice. However, this example serves to demonstrate how highly toxic some agents really are.

Persistency is a measure of the length of time an agent remains a hazard on the battlefield. Nonpersistent agents tend to be rather volatile and evaporate quickly; these dissipate within a few minutes to about one hour. Semipersistent agents generally linger for several hours to one day. Persistent agents, which tend to be rather thick and oily, can last for several days to a few weeks. Agents can also be "thickened" to increase persistency by adding one of a variety of viscous materials. The mixing of thickeners with soman. for example, will increase the persistency of soman. However, the actual length of time an agent remains a hazard varies widely according to the environment (soil, vegetation, and so forth) and meteorological conditions (temperature, wind speed, atmospheric stability, moisture, and sunlight). Just as a puddle of water evaporates more quickly on a hot, sunny, breezy July afternoon than on a cool, foggy, calm December morning, CW agents will dissipate more rapidly when exposed to high temperatures and wind speeds and an unstable atmosphere.

State refers to the physical form of the agent. CW agents can be any of the three basic states of matter—solid, liquid, or gas—but most are liquids. Thus, the terms "nerve gas," "mustard gas," and "poison gas" are misnomers. These misnomers stem from the dissemination of liquid agents as aerosol or vapor clouds, which act like gases.

CW Agents and Field Employment

In general, the amount of CW agent delivered determines the extent of contamination and the number of casualties. A rough rule of thumb is that 1 ton (or about four 55-gallon drums) of agent is enough to effectively contaminate 1 square mile of territory if properly disseminated. The number of resultant casualties depends on the number of people in the contaminated area, length of warning, and degree of protection, as well as the persistency and lethality of the agent used. The persistency of a specific agent (length of time it remains effective) varies depending on the type of munition used and the weather conditions. In all cases, given sublethal doses of an agent, incapacitation will occur to varying degrees.

First-Generation Agents

Choking agents are the oldest CW agents. This class of agents includes chlorine and phosgene, both of which were used in World War I. In sufficient concentrations, their corrosive effect on the respiratory system results in pulmonary edema, filling the lungs with fluid and choking the victim. Phosgene is more effective than chlorine because it is slowly hydrolyzed by the water in the lining of the lungs, forming hydrochloric acid that rapidly destroys the tissue.

These agents are heavy gases that remain near ground level and tend to fill depressions such as foxholes and trenches. Because they are gases, they are nonpersistent and dissipate rapidly in a breeze. As a result, these are among the least effective traditional CW agents. They are useful for creating a short-term respiratory hazard on terrain that is to be quickly occupied.

Blood agents are absorbed into the body primarily by breathing. They prevent the normal utilization of oxygen by the cells and cause rapid damage to body tissues. Blood agents such as hydrogen cyanide (AC) and cyanogen chloride (CK) are highly volatile and in the gaseous state dissipate rapidly. Because of their high volatility, these agents are most effective when surprise can be achieved against troops who do not have masks or who are poorly trained in mask discipline. In addition, blood agents are ideally suited for use on terrain that the user hopes to occupy within a short time. Blood agents rapidly degrade a mask filter's effectiveness. Therefore, these agents could also be used to defeat a mask's protective capabilities when combined with other agents. **Blister (vesicant) agents** are primarily used to cause medical casualties. These agents may also be used to restrict use of terrain, to slow movements, and to hamper use of materiel and installations. Blister agents affect the eyes and lungs and blister the skin. Sulfur mustard, nitrogen mustard, and lewisite are examples of blister agents. Most blister agents are insidious in action; there is little or no pain at the time of exposure except with lewisite, which causes immediate pain on contact.

Sulfur mustard is considered by some to be the ideal CW agent. It presents both a respiratory and a percutaneous hazard, forcing military personnel to don not only gas masks but also cumbersome protective overgarments—seriously degrading their ability to function. Mustard is persistent and presents a long-term hazard, further hindering victims by forcing them to decontaminate. Being based on old technology, it is simple to produce, even by Third World standards. Moreover, it causes large numbers of long-term, debilitating injuries whose treatment can easily overburden an enemy's war effort.

From a CW perspective, an advantage of mustard over lewisite is that the latter hydrolyzes very rapidly upon exposure to atmospheric moisture to form a nonvolatile solid. This conversion lowers the vapor hazard from contaminated terrain and decreases the penetration of the agent through clothing. Lewisite is less persistent than mustard; however, the persistency of both is limited under humid conditions.

Second-Generation Agents

G-series nerve agents. including tabun (GA), sarin (GB), soman (GD), and GF, are members of a class of compounds that are more lethal and quicker acting than mustard. They are organophosphorus compounds that inhibit action of the enzyme acetylcholinesterase. These agents are similar to many pesticides and, in fact, were accidentally discovered in the 1930s by German chemists seeking new types of pesticides.

G-series agents act rapidly (within seconds of exposure) and may be absorbed through the skin or the respiratory tract. However, some of these agents, particularly GA and GB, tend to be relatively nonpersistent and consequently present less of a skin hazard than a vapor hazard. In sufficient concentration, the ultimate effect of these agents is paralysis of the respiratory musculature and subsequent death. Exposure to a lethal dose may cause death in as little as several minutes. These less persistent agents are used to cause immediate casualties and to create a short-term respiratory hazard on the battlefield. Persistent G-series nerve agents such as GS and GF would present more of a skin hazard.

Third-Generation Agents

V-series nerve agents, including VE, VG, VM, VS, and VX, are compounds similar to, but more advanced than, G-series nerve agents. Developed in the 1950s by the British, these agents tend to be more toxic and more persistent than G-agents. They present a greater skin hazard and are used to create long-term contamination of territory.

Nonlethal Agents

Tear gas agents fall under the broader category of riot control agents. They are not considered by the US Government to be CW agents because they are nonlethal in all but the highest concentrations. Examples of these agents include orthochlorobenzylidene malononitrile (CS), chloroacetophenone (CN), chloropicrin (PS), and bromobenzyl cyanide (BBC). They are highly irritating, particularly to the eyes and respiratory tract, and cause extreme discomfort. Symptoms occur almost immediately upon exposure and generally disappear shortly after exposure ceases.

In military situations, tear gas agents are used to temporarily reduce the effectiveness of enemy personnel. In tactical operations, they can be used to penetrate fortified positions and flush out the enemy. Also, these agents are useful for disrupting "human wave" assaults by breaking up formations and destroying the momentum of the attack. Because tear gas agents are nonlethal, they can be used near friendly troops without risking casualties; thus, their use is more flexible than with conventional CW agents.

Vomiting agents are often considered to be riot control agents because, under field conditions, they cause great discomfort but rarely serious injury or death.

Characteristic agents include adamsite (DM) and diphenyl chloroarsine (DA). In addition to causing vomiting, these arsenic-based agents may also irritate the eyes and respiratory system.

The action of voniting agents may make it impossible to put on, or continue wearing, a protective mask. Therefore, in military situations, vomiting agents may be used in conjunction with lethal CW agents to increase casualties. They may also be used by themselves in proximity to friendly troops and in other situations well suited for tear gas agents.

Psychochemicals, also considered incapacitants, include hallucinogenic compounds such as *lysergic* acid diethylamide (LSD), 3-quinuclidinyl benzilate (BZ), and benactyzine. These agents alter the nervous system, thereby causing visual and aural hallucinations, a sense of unreality, and changes in the thought processes and behavior. Psychochemicals are generally characterized by a slightly delayed onset of symptoms and by a persistence of symptoms for a period greatly exceeding exposure time.

The advantage of psychochemicals is their ability to inactivate both civilian and military personnel for a relatively shortperiod with essentially no fatalities. Thus, their use may prove advantageous in areas with friendly populations. One drawback, however, is that the effects of many of these agents are unpredictable.

Chemical Weapons

There are many different ways to disseminate CW agents. Most common are the free-flight munitions that are fired at or dropped on a target. These can be weaponized in unitary or binary form, and the larger munitions can contain submunitions. It is also possible to disseminate agent from a spray tank attached to an aircraft or from a ground-based aerosol generator.

Most conventional munitions can be modified to deliver lethal or nonlethal chemical agents. Typical chemical munitions include:

- · Aerial bombs.
- · Artillery rockets.

• Artillery shells.

Grenades.

• Mines.

• Missile warheads.

Mortar rounds.

These normally contain burster charges surrounded by bulk-fill agent. The burster ruptures the munition and causes the agent to be disseminated as a stream or cloud of small droplets.

Air- or ground-based aerosol generators can be used for more controlled dissemination of CW agents. A spray tank can be used to disseminate agents from aircraft, just as crop dusters are used to spread insecticides. Similarly, the same type of ground-based aerosol generators used to disseminate pesticides can be used for CW purposes. One drawback of these systems, however, is limited survivability during wartime.

Chemical munitions usually fall into one of two categories: unitary or binary. A unitary munition contains the agent itself, while binary munitions contain two agent precursors that mix in the munition and form agent before or during flight. Unitaries are able to deliver more agent per munition, but binaries because they contain the less toxic precursors—are safer.

CW agents can also be carried in submunitions or bomblets. The submunitions are ejected from the primary munition some distance above the ground. They land on the ground in a random pattern and detonate, covering an area larger and more evenly than with a bulk-fill munition.

Optimum fuzing can vary depending on the agent. Impact fuzing, employed in ground-burst munitions, is best used in conjunction with volatile, nonpersistent agents, which generally will dissipate if disseminated at too great an altitude. Proximity fuzing—whether

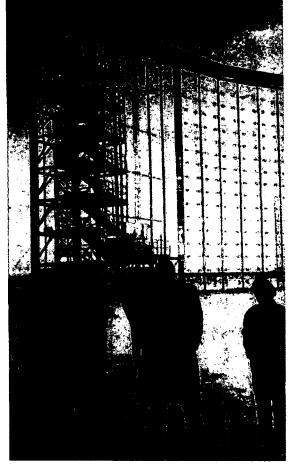


Figure 7. Example of a vertical acrosol test grid for open-air exposure

based on lasers, radar, barometric pressure, or timers—is best used in conjunction with persistent agents, which can be disseminated at higher altitudes and still reach the target.

CW Defense

There are four primary aspects of CW defense:

• *Protection.* Potential victims need to prevent CW agents from coming into contact with the body. This is accomplished by surrounding the body with a

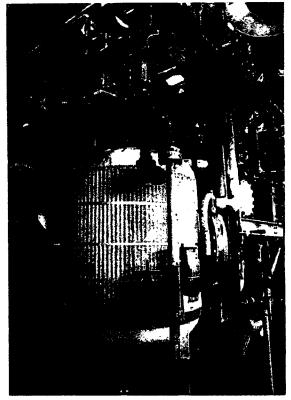


Figure 8. Chemical reactor

physical barrier consisting of a gas mask to filter air; a protective overgarment, boots, and gloves to keep agents away from the skin; and, sometimes, collective protective systems to do both. Masks usually are fitted with canisters filled with activated charcoal, which filters out CW agents as air is drawn through. Gloves and boots are almost always made of butyl rubber or a similar impermeable material that is resistant to CW agents. Some overgarments, such as those in the former Soviet Bloc countries, are impermeable as well. In contrast, Western overgarments are usually made of layers of activated charcoal sandwiched between two pieces of semipermeable fabric; these allow for ventilation.

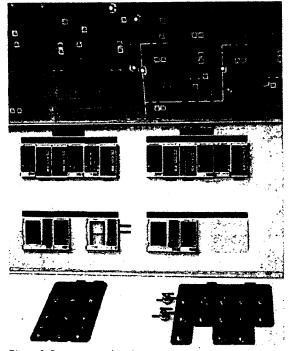


Figure 9. Process control equipment

- Detection. Adequate detection is needed to ensure that troops take adequate protective measures in time. Detectors range from electronic standoff instruments to treated paper. The time needed to detect CW agents can vary considerably.
- Decontamination. If equipment and personnel are exposed to a persistent agent, decontamination is needed to eliminate the hazard. Decontamination generally involves using a water-based caustic or bleach material to neutralize any agent present.
 Sodium hydroxide and sodium hypochlorite are two common constituents of decontaminant solutions.
- Treatment. If a victim is exposed to agent, prompt medical treatment is needed to counteract the agent and limit injuries. For example, atropine is the standard antidote for nerve-agent poisoning. This compound is injected into the bloodstream and often is

followed by a cholinesterase reactivator, such as pralidoxime chloride (or 2-PAM chloride). In addition, pretreatments, such as pyridostigmine, can be used before an attack to limit nerve-agent-related damage.

One important factor to consider is the degradation in performance caused by CW defense. Troops wearing protective overgarments function much less effectively than troops without, leading to a reduction in the effective strength of a military unit. Thus, a military advantage can be achieved merely by threatening to use chemical weapons. In addition, the need to decontaminate—such as the presence of a persistent agent—further reduces fighting ability.

Production of CW Agents

Many CW agents, particularly the first-generation agents, are simple to produce. They are often based on technology that is at least 80 years old and sometimes older, putting them well within the reach of virtually any Third World country that wants them. Newer agents, particularly the nerve agents, are more difficult to produce; however, the technology for these agents is widely available in the public domain.

In many ways, production of CW agents is like that of legitimate commercial compounds. Both involve use of standard chemical process equipment, including reactor vessels, in which production actually occurs; distillation columns and filters, where compounds are separated or purified; heat exchangers, to control temperature; and various pumps, pipes, valves, and other items that control the movement of chemicals throughout the plant. The greatest similarities occur between pesticide and nerve agent production units because these compounds are so closely related.

There are some pieces of equipment, such as those controlled by the Australia Group (see inset), that are distinct enough to warrant special consideration. For a

Australia Group

The Australia Group (AG) is an informal organization, currently consisting of 30 nations,^e committed to ensuring that exports of materials and equipment from their countries do not contribute to the spread of chemical or biological weapons. The group, formed in 1984, meets biannually to:

- Discuss and agree on measures to control the export of CBW-relevant material and equipment.
- Consider effective means of implementing and enforcing export controls.
- Exchange information on CBW proliferation.
- Discuss provisions to control activities that could contribute to CBW proliferation.
- Expand membership in the AG to other select nations and to encourage all countries to adopt export controls on relevant materials comparable to those adopted by the AG.

^a Current Australia Group members include Argentina. Australia. Austria. Belgium, Canada, Czech Republic, Denmark, Finland, France. Germany, Greece, Hungary. Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Slovakia. South Korea. Spain, Sweden, Switzerland, United Kingdom, and the United States.

Unclassified

detailed listing of this equipment, please see appendix G. In particular, equipment that is exceptionally resistant to corrosion—such as Hastelloy and other highnickel alloys—has important applications in CW because of the highly corrosive compounds encountered in CW agent production. Also worthy of suspicion are double-seal pumps and other equipment designed to handle exceptionally toxic compounds. To date, AG members have adopted export controls or agreed to institute controls on the following:

- Fifty-four chemical warfare agent precursor chemicals (see appendix G).
- Dual-use processing equipment that is applicable to the manufacture of CW agents and precursor chemicals.
- Human, animal, and plant pathogens and toxins with potential BW applications.
- Dual-use biological equipment, suitable for development, production, or dissemination of BW agents.

The embargoes on CBW-relevant material and equipment have impeded but not stopped CBW weapons proliferation. However, by continuing to focus on export controls, the AG will remain a viable force in curtailing the spread of CBW weapons and will play a complimentary role to the Chemical and Biological Weapons Conventions' goals of completely eliminating these weapons from world arsenals.

Chemical Weapons Convention

The Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (Chemical Weapons Convention or CWC), opened for signature on January 13, 1993. It is the first disarmament agreement negotiated within a multilateral framework that provides for the elimination of an entire category of weapons of mass destruction under universally applied international control.

The CWC entered into force on April 29, 1997 with 87 nations ratifying the Treaty (165 nations have signed it-see figure 10). The Organization for the Prohibition of Chemical Weapons (OPCW), located in The Hague, Netherlands, is charged with implementing the provisions of the Convention. The OPCW will comprise a Conference of States Party (CSP), an Executive Council (EC), and a Technical Secretariat (TS). The CSP consists of all States Parties and will meet annually in plenary to review the implementation and approve new policies/procedures. The EC consists of 41 elected States Parties and will oversee and provide guidance to the TS. Staffed by international civil servants from ratifying States, the TS is responsible for carrying out the day-to-day verification activities of the OPCW. It will be responsible for gathering data, conducting inspections, and communicating with a States Party via a National Authority, the State's focal point for CWC implementation.

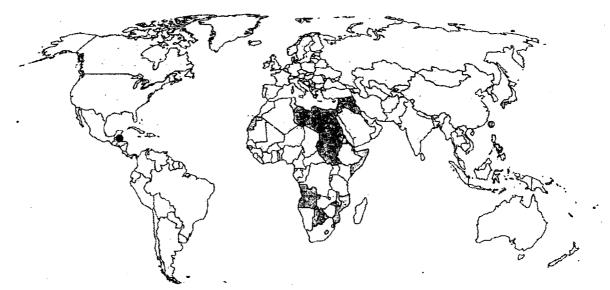
The Convention prohibits the development, production, acquisition, retention, stockpiling, transfer, and use of chemical weapons. It requires each State Party to destroy chemical weapons and chemical weapons production facilities (unless it receives permission to convert) under its jurisdiction and control, as well as any chemical weapons it might have abandoned on another States territory. States Parties are never to engage in any military preparations to use chemical weapons; nor to assist or encourage others to engage in any of the proscribed activities; and not to use riot control agents as a method of warfare.

The OPCW will monitor States' adherence to these provisions through declarations and inspections. Each Party is require to declare its past CW activities and related destruction programs as well as some government and commercial facilities which could support a CW program. This last category is based on varying thresholds for production, processing, and/or consumption of chemicals listed on three "Schedules" (see appendixes I-L).² The Schedules contain many, but not all, chemicals which have been used in CW production. The declaration threshold and inspection requirement are based on the degree of commercial use the specific chemical has-the broader the commercial use, the higher the declaration threshold and the lower the number and intrusiveness of routine inspections. Production of Schedule 1 chemicalslargely actual agent-is limited to 1 metric ton per year per State for defensive purposes only. In addition, the CWC regulates the export of Scheduled chemicals to varying degrees, prohibiting the transfer by Parties of Schedule 1 and, eventually, Schedule 2 chemicals to non-States Parties. Moreover, the CWC requires the use of end-use certificates for the export of all scheduled chemicals. CW-related facilities will be inspected more frequently, and destruction activities will be monitored continuously.

States Parties have the right to request a Challenge Inspection of any site or facility in another State Party suspected of noncompliance. Unless the EC votes to cancel it, the TS must conduct the inspection. However, in order to protect national security and proprietary information, the facility is allowed to deny access to some areas and data. The Convention also contains a Confidentiality Annex which obligates the OPCW and States Party to protect any sensitive information from public disclosure or misuse.

² Scheduled compounds are used only for declaration/inspection purposes. Each Schedule has its own definition allowing for expansion or contraction of the lists as the field of chemistry expands and new chemicals are determined to have CW applications.

Figure 10 Status of Ratifications for the Chemical Weapons Convention as of 1 May 1997



Ratifications (87)*

Albania Maldives Denmark Algeria Ecuador Mali Argentina El Salvador Malta Armenia Equatorial Guinea Mauritius Australia Ethiopia Mexico Austria Fiji Moldova **Bahrain** Finland Mongolia Bangladesh France Monaco Belarus Georgia Morocco Belgium Germany Namibia Bosnia and Greece Netherlands Herzegovina Hungary New Zealand Brazil Iceland Niger Bulgaria India Norway Cameroon Ireland Oman Canada Italy Papua New Guinea Chile Japan Paraguary China Kenya Peru **Cook Islands** Laos Philippines Costa Rica Latvia Poland Cote d'Ivoire Lesotho Portugal Croatia Luxembourg Romania **Czech Republic**

St. Lucia Saudi Arabia Seychelles Slovakia South Africa South Korea Spain Sn Lanka Sunname Swaziland Sweden Switzerland Tajikistan Togo Tunisia Turkmenistan **United Kingdom** United States Uruguay Uzbekistan Zimbabwe

and the state of the second	
anone consistence	3
	1
1 11G Fr	
a-Elettide Philippine	1.67
ing an	• •
L. E. Martin	
S S S S S S S S S S S S S S S S S S S	
, Reits	
ALUTRAESTA,	
Configuration and a second	Í
- J#V#	
. Hanayan Tanan ta anal i	
a request of contractions.	
Standard Ashering	.5
Stern Lenn	;;
Stephene and Werene march	
Storestille	
- Statisti	
S. First	
1. Hattar in	
- Waring Service	
ME AS THE MAN AND SHARE AND	

Signatories

65th ratification triggered EIF for 29 April 1997.

^bNot recognized; cannot sign or ratify.

Appendix F

Chemical Warfare Agents

,

Agent Class	Agent	Sýmbol	Persistency	Rate of Action
Nerve	Tabun	GA	Low	Very rapid
	Sarin	GB	Low	Very rapid
	Soman	GD	Moderate	Very rapid
	GF	GF	Moderate	Very rapid
	vx	VX	Very high	Rapid
Blister	Sulfur mustard	H,HD	Very high	Delayed
	Nitrogen mustard	HN-I	High	Delayed
	-	HN-2	Moderate	Delayed
		HN-3	Very high	Delayed
	Phosgene oxime	CX	Low	Immediate
	Lewisite	L	High	Rapid
	Phenyldichloroarsine	PD	Low-moderate	Rapid
	Ethyldichloroarsine	ED	Moderate	Delayed
	Methyldichloroarsine	MD	Low	Rapid
Choking	Phosgene	CG	Low	Delayed
	Diphosgene	DP	Low	Variable
Blood	Hydrogen cyanide	AC	Low	Rapid
	Cyanogen chloride	СК	Low	Rapid
	Arsine	SA	Low	Delayed
Riot control (vomiting)	Diphenylchloroarsine	DA	Low	Rapid
	Diphenylcyanoarsine	DC	Low	Rapid
	Adamsite	DM	Low	Rapid
Riot control (tear gas)	Chloroacetophenone	CN	Low	Immediate
	Chloropicrin	PS	Low-high	Immediate
	Bromobenzylcyanide	CA	Moderate-very high	Immediate
	O-chlorobenzylidene malononitrile	CS	Low-high	Immediate
Psychochemicals	3-Quinuclidinyl benzilate	BZ	High	Delayed

Approved for Release: 2015/10/28 C06464615

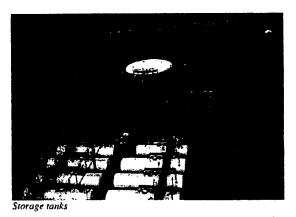
.

Appendix G

General Guidelines for Identifying Dual-Use Chemical Equipment and Related Technology

Manufacturing Facilities and Equipment

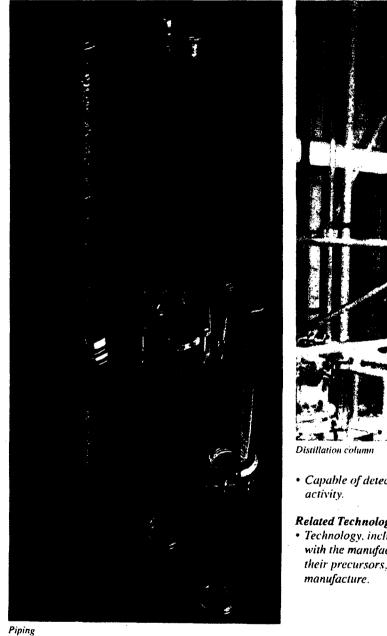
- Reactor vessels and agitators (with total volume greater than 100 liters and less than 20,000 liters)
- Storage tanks, containers, and receivers (with total volume greater than 100 liters)
- · Heat exchangers or condensers
- Distillation or absorption columns
- Valves and multiwalled piping (multiple-seal valves, bellows-seal valves, diaphragm valves, and multiwalled piping incorporating a leak detection port)
- Pumps (multiple-seal, canned-drive, magnetic drive, bellows or diaphragm pumps having a flow rate greater than 0.6 cubic meter per hour or vacuum pumps with a flow rate greater than 5 cubic meters per hour)
- Materials of construction for all surfaces of the forgoing equipment in direct contact with the chemicals being processed:
 - Nickel or alloys with more than 40-percent nickel by weight.
 - Alloys with more than 25-percent nickel and 20-percent chromium by weight.
 - Fluoropolymers.
 - Glass or glass lined.
 - Tantalum, titanium, zirconium, or their alloys.
 - Graphite (for heat exchangers, pumps, and multiwalled piping only).
 - Ceramics or ferrosilicon (for pumps only).
- Filling equipment (remotely operated)
- Materials of construction for all surfaces of the forgoing equipment in direct contact with the chemicals being processed:



- Nickel or alloys with more than 40-percent nickel by weight.
- Alloys with more than 25-percent nickel and 20-percent chromium by weight.
- Incinerators (with an average combustion chamber temperature greater than 1,000 degrees Celsius)
- Materials of construction for all surfaces of the forgoing equipment in direct contact with the chemicals being processed:
 - Nickel or alloys with more than 40-percent nickel by weight.
 - Alloys with more than 25-percent nickel and 20-percent chromium by weight.
 - Ceramics.
- Whole plants

Toxic Gas Monitoring Systems • Detectors

— Designed for continuous operation and capable of detecting chemical warfare agents and designated chemical warfare agent precursors as well as organic compounds containing phosphorus, sulfur, fluorine, and chlorine at a concentration less than 0.3 milligram per cubic meter of air. General Guidelines for Identifying Dual-Use Chemical Equipment and Related Technology



• Capable of detecting cholinesterase-inhibiting **Related Technology** • Technology, including licenses, directly associated with the manufacture of chemical weapons agents, their precursors, or dual-use equipment for such

١

Appendix H

1

CW Agent Precursor Chemicals: Uses and Equivalents

Precursor Chemical	Civil Uses	CW Agent Production	Units of Agent per Unit of Precursor*
1. Thiodiglycol	Organic synthesis	Sulfur mustard (HD)	1.3
111-48-8	Carrier for dyes in textile industry		
	Lubricant additives	Sesqui mustard (Q)	1.79
	Manufacturing plastics		
2. Phosphorus oxychloride	Organic synthesis	Tabun (GA)	1.05
10025-87-3	Plasticizers		
	Gasoline additives		
	Hydraulic fluids		
	Insecticides		
	Dopant for semiconductors grade silicon		
	Flame retardants		
3. Dimethyl methylphosphonate	Flame retardants	Sarin (GB)	1.12
(DMMP) 756-79-6	•	Soman (GD)	
		GF	1.45
4. Methylphosphonyl difluoride	Organic synthesis	Sarin (GB)	1.40
576-99-3	Specific uses not identified	Soman (GD)	1.82
		GF	1.80
5. Methylphosphonyl dichloride	Organic synthesis	Sarin (GB)	1.05
676-97-1	Specific uses not identified	Soman (GD)	1.36
		GF	1.35
6. Dimethylphosphite	Organic synthesis	Sarin	1.27
868-85-9	Lubricant additive	Soman	1.65
	·	GF	1.65
7. Phosphorus trichloride	Organic synthesis	VG	1.95
7719-12-2	Insecticides	Tabun (GA)	1.18
	Gasoline additives	Sarin (GB)	1.02
	······································	Salt process	(0.34)
	Plasticizers	Rearrangement process	1.02
	·		(0.68)
	Surfactants	Soman (GD)	1.32
		Salt process	(0.44)
	Dyestuffs	Rearrangement process	1.32
			(0.88)
•		GF	1.31
		Salt process	(0.44)
		Rearrangement process	1.31
			(0.87)
8. Trimethyl phosphite 121.45-9	Organic synthesis	Used to make dimethyl methyl- phosphonate (DMMP)-molecu- lar rearrangement	See dimethyl methylphospho nate

1

CW Agent Precursor Chemicals: Uses and Equivalents (continued)

Precursor Chemical	Civil Uses	CW Agent Production	Units of Agent per Unit of Precursor*
9. Thionyl chloride •	Organic synthesis	Sarin (GB)	1.18
7719-09-7		Soman (GD)	1.53
		GF	1.51
		Sulfur mustard (HD)	1.34
	Chlorinating agent	Sesqui mustard (Q)	1.84
	Catalyst	Nitrogen mustard (HN-1)	0.714
	Pesticides	Nitrogen mustard (HN-2)	0.655
	Engineering plastics	Nitrogen mustard (HN-3)	1.145
10. 3-Hydroxy-1-methylpiperidine 3554-74-3	Specific uses not identified. Probably used in pharmaceutical industry.	Nonidentified. Could probably be used in the synthesis of psychoac- tive compounds such as BZ.	
II. N.N-diisopropyl-(beta)-	Organic synthesis	vx	1.64
uminoethyl chloride 96-79-7		VS	1.72
2. N.N-diisopropyl-	Organic synthesis	VX	1.66
minoethancthiol 1842-07-9		VS	1.75
3. 3-Quinuclidinol	Hypotensive agent	BZ	2.65
1619-34-7	Probably used in synthesis of pharmaceuticals		
4. Potassium fluoride	Fluorination of organic compounds	Sarin (GB)	2.41
7789-23-3	Cleaning and disinfecting brewery, dairy and other food processing equipment.	Soman (GD)	3.14
	Glass and porcelain manufacturing	GF	3.10
15. 2-Chloroethanol	Organic synthesis	Sulfur mustard (HD)	0.99
107-07-3	Manufacturing of ethylene-oxide	Sesqui mustard	0.99
	and ethylene-glycol	Nitrogen mustard (HN-1)	1.06
	Insecticides		
	Solvent		
16. Dimethylamine	Organic synthesis	Tabun (GA)	3.61
124-40-3	Pharmaceuticals		
	Detergents		
	Pesticides		
	Gasoline additive		
	Missile fuels		
	Vulcanization of rubber		
7. Diethyl ethylphosphonate	Heavy metal extraction	Ethyl sarin (GE)	0.93
78-38-6	Gasoline additive		
	Antifoam agent		
	Plasticizer		

٩

4

CW Agent Precursor Chemicals: Uses and Equivalents (continued)

Precursor Chemical	Civil Uses	CW Agent Production	Units of Agent per Unit of Precursor*
18. Diethyl N.N-dimethyl	Organic synthesis	Tabun (GA)	0.90
phosphoramidate 2404-03-7	Specific uses not identified		
19. Dicthylphosphite	Organic synthesis	VG	Catalyst
762-04-9	Paint solvent	Sarin (GB)	1.02
	Lubricant additive	Soman (GD)	1.32
		GF	1.30
20. Dimethylamine HCl	Organic synthesis	Tabun (GA)	1.99
i06-59-2	Pharmaceuticals		
	Surfactants		
	Pesticides		
	Gasoline additives		
21. Ethylphosphonous dichloride	Organic synthesis	VE	1.93
1498-40-4	Specific uses not identified but could be	VS	2,14
	used in manufacturing of flame retardants, gas additives, pesticides, surfactants, etc.	Ethyl sarin (GE)	1.18
22. Ethylphosphonyl dichloride	Organic synthesis	Ethyl sarin (GE)	2.10
1066-50-8	Specific uses not identified. See ethylphosphonous dichloride.		
23. Ethylphosphonyl difluoride	Organic synthesis	Ethyl sarin (GE)	2.70
753-98-0	Specific uses not identified. See ethylphosphonous dichloride.	**************************************	
24. Hydrogen fluoride 7664-39-3	Fluorinating agent in chemical reactions	Sarin (GB)	7.0
	Catalyst in alkylation and polymerization reactions	Soman (GD)	9.11
	Additives to liquid rocket fuels	Ethyl sarin (GE)	7,7
	Uranium refining	GF	9.01
25. Methyl benzilate	Organic synthesis	BZ	1.39
76-89-1	Tranquilizers		
26. Methylphosphonous dichloride 576-83-5	Organic synthesis	VX	2.28
27. N.N-diisopropyl-(beta)-	Organic synthesis	VX	1.84
aminoethanol 96-80-0	Specific uses not identified		
28. Pinacolyl alcohol 464-07-3	Specific uses not identified	Soman (GD)	1.79
29. O-ethyl,2-diisopropyl aminoethyl methyl- phosphonate (QL) 57856-11-8	Specific uses not identified	vx	1.14
30. Triethyl phosphite	Organic synthesis	VG	1.62
122-52-1	Plasticizers		
	Lubricant additives		

CW Agent Precursor Chemicals: Uses and Equivalents (continued)

Precursor Chemical	Civil Uses	CW Agent Production	Units of Agent per Unit of Precursor
31. Arsenic trichloride	Organic synthesis	Arsine	0.43
7784-34-1	Pharmaceuticals	Lewisite	1.14
	Insecticides		
	Ceramics	Adamsite (DM)	1.53
		Diphenylchloroarsine (DA)	1.45
32. Benzilic acid 76-93-7	Organic synthesis	BZ	1.48
33. Dicthyl methylphosphonite 15715-41-0	Organic synthesis	VX	1.97
34. Dimethyl ethylphosphonate 6163-75-3	Organic synthesis	Ethyl sarin (GE)	1.12
35. Ethylphosphonous difluoride	Organic synthesis	VE	2.58
30-78-4		Ethyl sarin (GE)	1.57
6. Methylphosphonous difluoride	Organic synthesis	VX	3.18
753-59-3		VM	2.84
		Sarin (GB)	1.67
		Soman (GD)	2.17
		GF	2.15
37. 3-Quinuclidone	Same as 3-Quinuclidinol	BZ.	2.65
1619-34-7	3-quinuclidinol		
38. Phosphorous pentachloride	Organic synthesis	Tabun (GA)	0.78
10026-13-8	Pesticides		
	Plastics		
39. Pinacolone 75-97-8	Specific uses not identified	Soman (GD)	1.82
40. Potassium cyanide	Extraction of gold and silver from ores	Tabun (GA)	1.25
151-50-8	Pesticide		
	Fumigant	Hydrogen cyanide	0.41
	Electroplating		
41. Potassium bifluoride	Fluorine production	Sarin (GB)	1.79
7789-29-9	Catalyst in alkylation	Soman (GD)	2.33
	Treatment of coal to reduce slag formation	GF	2.31
	Fluid in silver solder		
2. Ammonium bifluoride	Ceramics	Sarin (GB)	2.46
1341-49-7	Disinfectant for food equipment	Soman (GD)	3.20
	Electroplating	GF	3.16
	Etching glass		
13. Sodium fluoride	Pesticide	Sarin (GB)	3.33
7681-49-4	Disinfectant	Soman (GD)	4.34
	Dental prophylaxis	GF	4.29
	Glass and steel manufacturing		

Approved for Release: 2015/10/28 C06464615

CW Agent Precursor Chemicals: Uses and Equivalents (continued)

Precursor Chemical	Civil Uses	CW Agent Production	Units of Agen per Unit of Precursor*
14. Sodium bifluoride	Antiseptic	Sarin (GB)	2.26
1333-83-1	Neutralizer in laundry operations	Soman (GD)	2.94
	Tin plate production	GF	2.91
15. Sodium cyanide	Extraction of gold and silver from ores	Tabun (GA)	1.65
43-33-9	Fumigant	Hydrogen cyanide	0.55
	Manufacturing dyes and pigments	Cyanogen chloride	1.25
	Core hardening of metals		n fe sala sala yana yana yana yana yana sala sala sala sala sala sala sala s
	Nylon production		
6. Tricthanolamine	Organic synthesis	Nitrogen mustard (HN-3)	1.37
102-71-6	Detergents		
	Cosmetics		
	Corrosion inhibitor		<u>, , , , , , , , , , , , , , , , , , , </u>
	Plasticizer		
	Rubber accelerator	· · · · · · · · · · · · · · · · · · ·	
47. Phosphorus pentasulfide	Organic synthesis	VG	1.21
1314-80-3	Insecticide	VX	1.20
	Mitocides		
	Lubricant oil additives		· · · · · · · · · · · · · · · · · · ·
	Pyrotechnics		
48. Diisopropylamine	Organic synthesis	VX	3.65
108-18-9	Specific uses not identified	·····	
49. Diethylaminoethanol	Organic synthesis	VG	2.30
100-37-8	Anticorrosion compositions	VM	2.05
	Pharmaceuticals		
	Textile softeners	and and the second s	
50. Sodium sulfide	Paper manufacturing	Sulfur mustard (HD)	2.04
1313-82-2	Rubber manufacturing		
	Metal refining		
	Dye manufacturing		
51. Sulfur monochloride	Organic synthesis	Sulfur mustard (HD)	1.18
sulfur chloride 10025-67-9	Pharmaceuticals		
	Sulfur dyes		
	Insecticides		
	Rubber vulcanization		
	Polymerization catalyst		
	Hardening of soft woods		
	Extraction of gold from ores		

CW Agent Precursor Chemicals: Uses and Equivalents (continued)

Precursor Chemical	Civil Uses	CW Agent Production	Units of Agent per Unit of Precursor*
52. Sulfur dichloride	Organic synthesis	Sulfur mustard (HD)	1.54
10545-99-0	Rubber vulcanizing		·
	Insecticides		
, ,	Vulcanizing oils		
	Chlorinating agent		
53. Triethanolamine	Organic synthesis	Nitrogen mustard	1.10
hydrochloride (HN-3)	Insecticides	·	
	Surface active agents		
	Waxes, polishes		
	Textile specialties		
	Lubricants		
	Toiletries		
• · ·	Cement additive		
	Petroleum demulsifier		4
	Synthetic resin		
54. N.N-diisopropyl-2-aminoethyl chloride hydrochloride	Organic synthesis	VX	1.34

Figures in parentheses are based on the use of PCI3 as a chlorine donator in the reaction.
 Thionyl chloride could serve as chlorinating agent in all of these processes—other chlorinating agents could be substituted.

Appendix I

CWC Schedules of Chemicals: Guidelines

The following Schedules list toxic chemicals and their precursors. For the purpose of the Chemical Weapons Convention (CWC), these schedules identify chemicals for the application of verification measures. Pursuant to Article II of the Convention, these schedules do not constitute a definition of chemical weapons. (A chemical marked "*" on Schedule 2 under Toxic chemicals is subject to special thresholds for declaration and verification, as specified in Part VII of the Verification Annex of the CWC.)

Guidelines for Schedule 1 Chemicals

Criteria in considering whether a toxic chemical or precursor should be included in Schedule 1:

- Developed, produced, stockpiled or used as a chemical weapon as defined by the CWC
- Poses otherwise a high risk to the object and purpose of the CWC by virtue of its high potential for use in activities prohibited under the CWC because one or more of the following conditions are met:
 - Possesses a chemical structure closely related to other toxic chemicals listed in Schedule 1, and has, or can be expected to have, comparable properties.
 - Possesses such lethal or incapacitating toxicity as well as other properties that would enable it to be used as a chemical weapon.
 - May be used as a precursor in the final technological stage of production of a toxic chemical in Schedule 1, regardless of whether this stage takes place in facilities, in munitions or elsewhere.
- It has little or no use for purposes not prohibited under the CWC.

Guidelines for Schedule 2 Chemicals

Criteria in considering whether a toxic chemical not listed in Schedule 1 or a precursor to a Schedule 1 chemical or to a chemical listed in Schedule 2 under Toxic chemicals should be included in Schedule 2:

- Poses a significant risk to the object and purpose of the CWC because it possesses such lethal or incapacitating toxicity as well as other properties that could enable it to be used as a chemical weapon.
- May be used as a precursor in one of the chemical reactions at the final stage of formation of a chemical listed in Schedule 1 or Schedule 2 under Toxic chemicals.
- Poses significant risk to the object and purpose of the CWC by virtue of its importance in production of a chemical listed in Schedule 1 or Schedule 2 under Toxic chemicals.
- Is not produced in large commercial quantities for purposes not prohibited under the CWC.

Guidelines for Schedule 3 Chemicals

Criteria in considering whether a toxic chemical or precursor, not listed in other Schedules, should be included in Schedule 3:

- Has been produced, stockpiled as used as a chemical weapon.
- Poses otherwise a risk to the object and purposes of the CWC because it possesses such lethal or incapacitating toxicity as well as other properties that might enable it to be used as a chemical weapon.
- Poses a risk to the object and purpose of the CWC by virtue of its importance in the production of one or more chemicals listed in Schedule 1 or Schedule 2 under Precursors.
- May be produced in large commercial quantities for purposes not prohibited under the CWC.

43

i

Appendix J

CWC: Schedule 1 Chemicals

Substance	Chemical Abstracts Service Registry Number
Toxic chemiculs	
O-Alkyl (≤ C10, including cycloalkyl) alkyl (Me, Et, n-Pr)-phosphonofluoridates	
Sarin: O-Isopropyl methylphosphonofluoridate	107-44-8
Soman: O-Pinacolyl methylphosphonofluoridate	96-64-0
O-Alkyl (≤ C10, including cycloalkyl) N, N-dialkyl (Me, Et, n-Pr or i-Pr)-phosphoramidocyanidates	
Tabun O-Ethyl N, N-dimethyl phosphoramidocyanidate	77-81-6
O-Alkyl (H or \leq C10, including cycloalkyl) S-2-dialkyl (Me, Et, n-Pr or i-Pr) aminoethyl alkyl (Me, Et, n-Pr or i-Pr)-phosphonothiolates and corresponding alkylated or protonated salts	
VX: O-ethyl S-2-diisopropylaminoethyl methyl phosphonothiolate	50782-69-9
Sulphur mustards: 2-Chlorethylchloromethylsulfide	2625-76-5
Mustard gas: Bis (2-chloroethyl) sulfide	505-60-2
Bis (2-chloroethyltio) methane	63869-13-6
Sesquimustard: 1, 2-Bis (2-chloroethylthio) ethane	3563-36-8
1, 3-Bis (2-chloroethylthio)-n-propane	63905-10-2
1, 4-Bis (2-chloroethylthio)-n-butane	142868-93-7
1, 5-Bis (2-chloroethylthio)-n-pentane	142868-94-8
Bis (2-chloroethylthiomethyl) ether	63918-90-1
O-Mustard: Bis (2-chloroethylthioethyl) ether	63918-89-8
Lewisites	
Lewisite 1: 2-Chlorovinyldichloroarsine	541-25-3
Lewisite 2: Bis (2-chlorovinyl) chloroarsine	40334-69-8
Lewisite 3: Tris (2-chlorovinyl) arsine	40334-70-1
Nitrogen mustards	
HN1: Bis (2-chloroethyl) ethylamine	538-07-8
HN2: Bis (2-chloroethyl) methylamine	51-75-2
HN3: Tris (2-chloroethyl) amine	555-77-1
Saxitoxin	35523-89-8
Ricin	9009-86-3
Precursors	
Alkyl (Me, Et, n-Pr or i-Pr) phosphonyldifluorides	
DF: Methylphosphonyldifluoride	676
O-Alkyl (H or < C10, including cycloalkyl) O-2-dialkyl (Mc, Et, n-Pr or i-Pr)-aminoethyl alkyl (Me, Et, N-Pr or i-Pr) phosphonites and corresjonding alkylated or protonated salts	
QL: O-Ethyl O-2-diisopropylaminoethyl methylphosphonite	57856-11-8
Chlorosarin: O-Isopropyl methylphosphonochloridte	1445-76-7
Chlorosoman: O-Pinacolyl methylphosphonochloridate	7040-57-5

Appendix K

CWC: Schedule 2 Chemicals

Substance	Chemical Abstracts Service Registry Number
Toxic chemicals	
Amiton: O, O-Diethyl S-[2-(diethylamino) ethyl] phosphorothiolate and corresponding alkylated or protonated salts	78-53-5
PFIB: 1, 1, 3, 3, 3-Pentafluoro-2-(trifluoromethyl)-1-propene	382-21-8
BZ: 3-Quinuclidinyl benzilate*	6581-06-2
Precursors	
Chemicals, except for those listed in Schedule 1, containing a phosphorous atom to which is bonded one methyl, ethyl, or propyl (normal or iso) group but not further carbon atoms	
Methylphosphonyl dichloride	676-97-1
Dimethyl methylphosphonate	756-79-6
Exemption: Fonofos: O-Ethyl S-phenyl ethylphosphono thiolothionate	944-22-9
N. N-Dialkyl (Me, Et, n-Pr or i-Pr) phosphoramidic dihalides	
Diaklyl (me, Et. n-Pr or i-Pr) N, N-dialkyl (Me. Et. n-Pr or i-Pr)-phosphoramidiates	
Arsenic trichloride	7784-34-1
2, 2-Diphenyl-2-hydroxyacetic acid	76-93-7
Zuinuclidine-3-ol	1619-34-7
N. N-Dialkyl (Me. Et. n-Pr or i-Pr) aminoethyl-2-chlorides and corresponding protonated salts	
N, N-Dialkyl (Me, Et, n-Pr or I-Pr) aminoethane-2-ols and corresponding protonated salts	
Exemptions: N.N-Dimethylaminoethanol and corresponding protonated salts	108-01-0
N. N-Diethylaminoethanol and corresponding protonated salts	100-37-8
N. N-Dialkyl (Me, Et, n-Pr or i-Pr) aminoethane-2-thiols and corresponding protonated salts	•
Thiodiglycol: Bis (2-hydroxyethyl) sulfide	111-48-8
Pinacolyl alcohol: 3, 3-Dimethylbutane-2-ol	464-07-3

Appendix L

CWC: Schedule 3 Chemicals

Substance	Chemical Abstracts Service Registry Number
Toxic chemicals	
Phosgene: Carbonyl dichloride	75-44-5
Cyanogen chloride	506-77-4
Hydrogen cyanide	74-90-8
Chloropicrin: Trichloronitromethane	76-06-2
Precursors	
Phosphorus oxychloride	10025-87-3
Phosphorus trichloride	7719-12-2
Phosphorus pentachloride	10026-13-8
Trimethyl phosphite	121-45-9
Triethyl phosphite	122-52-1
Dimethyl phosphite	868-85-9
Diethyl phosphite	762-04-9
Sulfur monochloride	10025-67-9
Sulfur dichloride	10545-99-0
Thionyl chloride	7719-09-7
Ethyldiethanolamine	139-87-7
Methyldiethanolamine	105-59-9
Triethanolamine	102-71-6

Appendix M

Availability Review for Key Dual-Use Chemical Production Equipment

Item 1. Chemical process equipment constructed of Hastelloy, Monel, or another alloy with a nickel content in excess of 40 percent by weight, as follows: reactor vessels, storage tanks, and containers, heat exchangers, distillation columns, degassers, or condensers.

The chemical process equipment specified in this item is available from many countries in Europe, Asia, Latin America, Eastern Europe, and the independent republics of the former Soviet Union. These specifications encompass equipment suitable for treating certain common industrial wastes, sewage and potable water, as well as producing chemical and biological warfare agents. Following is a list of countries believed to have production capabilities for such chemical process equipment. In addition to the countries identified below, a scrap market exists from which a potential purchaser may obtain equipment.

The countries listed below are believed to be capable of manufacturing the chemical process equipment described.

Reactor Vessels

United Kingdom, France, Germany, Switzerland, Hungary, China, Japan, India, Brazil, South Korea, and Italy (also see Item 3 for glass-lined reactors).

Storage Tanks and Containers

Japan, Sweden, Korea. Germany, Taiwan, South Africa, Mexico, countries of former Yugoslavia, Czech Republic, France, and Russia and the other newly independent states.

Heat Exchangers

France, United Kingdom, China, Russia and the other . newly independent states, Germany, Japan, and Singapore.

Distillation Columns

France, United Kingdom, China, Russia and the other newly independent states. Germany, and Japan.



Heat exchanger

Condensers

These are available from manufacturers worldwide, including Third World countries.

Item 2. Thermometers or other sensors encased in alloy with a nickel content in excess of 40 percent.

Thermometers or other sensors are available worldwide and, for this purpose, can be placed in a thermalwell or encased as the end user specifies.

Item 3. Chemical process equipment listed in Item 1, which is lined with nickel, polyvinylidene fluoride, high-density polyethylene, or glass.

Chemical processing equipment with corrosion-resistant linings is also available worldwide. The principal manufacturers for nickel-lined, polyvinylidene fluoride-lined, and high-density polyethylene-lined equipment are in Western Europe and Japan.

For glass-lined equipment, the principal manufacturers are in Western and Eastern Europe, Japan, and South America, although China also possesses the capability to manufacture glass-lined equipment. The uses for this equipment range from the treatment of

Availability Review for Key Dual-Use Chemical Production Equipment (continued)

potable water, sewage, or industrial wastes to production of chemical and biological warfare agents.

Countries capable of manufacturing equipment lined with materials other than glass are identified below. For glass-lined equipment, specific companies are identified.

Lined With Nickel, Polyvinylidene Fluoride, and High-Density Polyethylene Japan, Germany, and Switzerland.

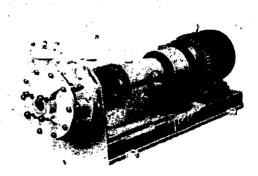
Glass-Lined Reactors

United Kingdom—Canon (subsidiary of GEC): Pfaudler Balfou; France—DeDetrich; Germany— Pfaudler Werke AG; Thalle (former GDR); Switzerland—Estella; Hungary—Lampart; Japan—Shinko Pan Tac; Hako Sanyo; India—GMN Pfaudler; Brazil—Pfaudler S.A.; Italy—Tycon and Technoglass.

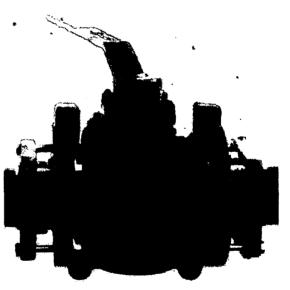
China and South Korea are also capable of producing this glass-lined equipment.

Item 4. Pumps and valves (a) incorporating a body made from alloy with a nickel content in excess of 40 percent by weight, or (b) lined with nickel, or (c) otherwise designed to be utilized with fluorine or hydrogen fluorine, or organophosphorus compounds. (Note: includes double-seal, electromagnetic drive, or canned pumps; bellows, or diaphragm valves meeting this specification.)

Based on a review of the manufacturers' buyer catalogs, pumps incorporating a body made from alloy with a nickel content in excess of 40 percent by weight are available from sources in Japan, Israel, and North Korea. Such pumps are also available from sources in Brazil, France, India, Israel, Taiwan, South Korea, South Africa, China, and Russia and the other newly independent states.



Pump



Valves

Valves, similarly made from nickel alloy, are also available from manufacturers in **France**, Israel, and **South Korea**. Below is a list of manufacturers identified for pumps and valves. Availability Review for Key Dual-Use Chemical Production Equipment (continued)

Pumps

Japan—Ebara, Teikoku, Nikkiso, Sanwa, Seikow Chemical, Iwaki, Kira, N.G.K.; Israel—Meltzer and Sons Ltd., Hameitz Pump MFG. Ltd.; South Korea— Korea Chemical Engineering Co., Ltd.

Valves

France—Gachot S.A.; Israel—Ham-Let Metal Products, Kim Production Ltd., EZM-MP Lachis Zafor; South Korea—Foxboro Korea, Ltd.

Item 5. Filling equipment enclosed in a glove box or similar environmental barrier, or incorporating a nickel-lined or Hastelloy nozzle.

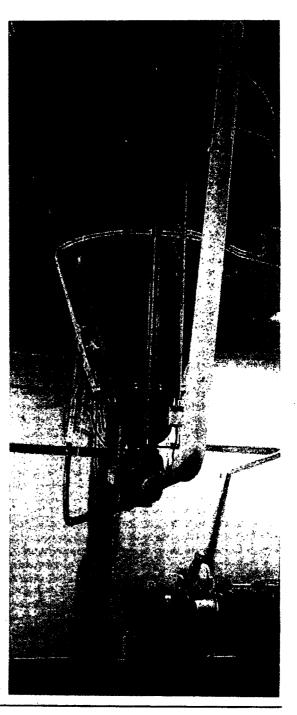
Filling equipment, as described in this item, is available from manufacturers within the Australia Group (AG) and the non-AG countries of China, Taiwan, and Russia and the other newly independent states. The manufacture of Hastelloy nozzles is probably limited to Germany and Italy, although nickel-lined nozzles are available and in abundant supply on a worldwide basis. Known manufacturers of Hastelloy nozzles are listed below.

Germany (Sprint Metal Edelstahlziehereien, Lechler, HP + HP, and Chemie-Stellglieder) and Italy (Cucchi Pompe and PNRI).

Item 6. Incinerators specially designed to incinerate (a) any chemical weapons agent or listed precursor; or (b) organophosphorus compounds.

Incinerators described in this item are available from AG and non-AG countries. Six countries with 13 manufacturers of this equipment are identified below, although Russia may also possess the capability to manufacture such incinerators.

Australia—Dorr-Oliver; Finland—Alsthom, Otokupo, and Tampella; Germany—Deutsche Babcock, Von Roll, Dorr-Oliver, and Lurgi; Japan—IHI;



Dryer

Availability Review for Key Dual-Use Chemical Production Equipment (continued)



Sweden—Asea Brown Boveri (ABB). Gotaverken, and Niro; Switzerland—Thyssen.

Item 7. Toxic gas monitoring systems designed to detect phosphorus, sulfur, or fluorine compounds, or designed to detect any CW agent, which are (a) designed for continuous operation, and (b) capable of detecting such chemicals at a concentration less than 0.1 milligram per cubic meter of air.

Toxic gas monitoring systems, as described in this item. are available from the United Kingdom and Russia and the independent republics of the former Soviet Union. The United Kingdom is considered a world leader in the manufacture of detection systems for hazardous gases. The former USSR reportedly had developed a semiautomatic gas analyzer capable of detecting toxic gas concentrations at a level of 0.05 milligram per cubic meter of air. The manufacturers for this type of equipment are listed below:

United Kingdom—SKC, Bruel & Kjaer, Neotronics. and Crowcon Instruments Ltd and Russia and the other newly independent states—Odessa State University.

Item 8. Monitoring systems for detection of chemical compounds having anticholinesterase activity.

The availability of monitoring systems capable of detecting anticholinesterase activity is widespread, with developments in Sweden, Finland, Russia and the other newly independent states, and the former Yugoslavia. A 1989 study indicated that the newly independent states' armed forces employed the PKHR-MV analyzer during field training exercises. Manufacturers of this item are listed below.

Former Yugoslavia—VTI facility; Sweden—FFC Ordnance: and Finland—Instrumentation Oy.

Evaporator

Glossary

Organization and Export Controls

Acetylcholinesterase

An enzyme that hydrolyzes the neurotransmitter acetylcholine. The action of this enzyme is inhibited by nerve agents.

Aerosol

A suspension of small, finely divided particles, either liquid or solid, in a gas; for example, fog or smoke.

Antibody

A protein made by vertebrates as the immune response to a foreign macromolecule or antigen.

Atropine

A compound used as an antidote for nerve agents. It is used medically in its sulfate form to inhibit the actions of acetylcholine in the parasympathetic nervous system.

BL/P Levels

There are four biosafety levels (BLs) that conform to specified conditions; these conditions consist of a combination of laboratory practices and techniques, safety equipment, and laboratory facilities appropriate for the operations performed and the hazard posed by the infectious agents. Formerly described as "physical containment (P)" levels.

Binary Munition

A chemical munition divided into two sections, each containing precursor chemicals that combine and react during flight, releasing a chemical agent upon impact.

Biological Warfare

The use, for military or terrorist purposes, of living organisms or material derived from them, which are intended to cause death or incapacitation in man, animals, or plants.

Bioregulators

Biochemicals that regulate physiological functions and are produced naturally in the body; in inappropriate concentrations, however, they can cause harmful effects.

Biotechnology

Applied biological science; for example, genetic engineering and biofermentation processes.

Blister Agent

A chemical agent that can cause blistering of the skin and extreme irritation of the eyes and lungs; although primarily an incapacitant, it can cause death in targe doses. Examples are sulfur mustard, nitrogen mustard, and lewisite.

Blood Agent

A chemical agent that acts on hemoglobin in blood cells, thus preventing oxygen from reaching cells. Examples are hydrogen cyanide and cyanogen chloride.

Chemical Warfare

The military use of toxic substances such that their chemical effects on exposed personnel result in incapacitation or death.

.

2

Choking Ag		Exotoxin	A toxin excreted by a microorganism
	A chemical agent that is typically a nonpersistent, heavy gas. It irritates the eyes and throat and, when inhaled, can		into the surrounding medium.
	lead to pulmonary edema, resulting in	G-Series Ne	rve Agents
	death from lack of oxygen. Examples		Chemical agents of moderate to high
	are chlorine and phosgene.		toxicity developed in the 1930s that act
	· ·		by inhibiting a key nervous system
Culture			enzyme. Examples are tabun (GA),
	A population of microorganisms grown in a medium.		sarin (GB), soman (GD), and GF.
		Genetic Eng	
Cutaneous			The directed alteration or manipulation
	Pertaining to the skin.		of genetic material.
DNA	· · · · · · · · · · · · · · · · · · ·	Hemoglobin	
	Deoxyribonucleic acid: the genetic		The constituent of red blood cells that
	material of all organisms and viruses		carries oxygen and gives them their
	(except for a small class of RNA-con-		color.
	taining viruses) that code for structures and materials used in normal metabo-	Infectious	
	lism.	inectious	Capable of producing disease in a sus-
			ceptible host.
Electrophor	A technique that separates molecules	LD50	
	based on size and/or charge.	6050	The dose (LD is lethal dose) that will
	cused on size and/or enarger		kill 50 percent of the exposed popula-
Endogenous	i		tion.
	Produced or originating from within.		
		Medium	
Endotoxin			A substance used to provide nutrients
	A toxin produced in an organism and		for the growth and multiplication of
	liberated after disruption of the cell		micro-organisms.
	wall.		-
Patonotou!-	a	Micro-orga	
Enterotoxin			Any organism of microscopic dimen-
	Toxins of bacterial origin specific for cells of the intestine.		sions.
		Monocional	Antibody
Enzyme			A single, pure antibody; made from
	A protein formed by living cells that		hybridoma cells.
	acts as a catalyst on physiological		
	chemical processes.		
Exogenous			
CAUGCHOUS	Produced or originating from without.		
	rocacca or originating from without,		

Nerve Agent

A chemical agent that acts by disrupting the normal functioning of the nervous system.

Nonlethal Agents

Chemical agents that can incapacitate but which, by themselves, are not intended to cause death. Examples are tear gas, vomiting agents, and psychochemicals such as BZ and LSD.

Organophosphorus Compound

A compound, containing phosphorus and carbon, whose physiological effects include inhibition of cholinesterase; many pesticides and virtually all nerve agents are organophosphorus compounds.

Pathogen

Any agent capable of producing disease, although usually applied to living agents.

Percutaneous

Through the skin; when applied to chemical agents, refers to route of entry into the body.

Persistence

A measure of the duration for which a chemical agent is effective. This property is relative, however, and varies by agent, by method of dissemination, and by environmental conditions such as weather and terrain.

Precursor

A chemical that can be chemically combined with another substance to form a chemical warfare agent. Most precursors controlled through international efforts have commercial uses as well.

Psychochemical Agent

An agent that incapacitates by distoring the perceptions and cognitive processes of the victim.

Pulmonary Edema

The excessive accumulation of fluid in lung tissue.

Recombinant DNA (rDNA)

DNA prepared in the laboratory by splitting and splicing DNA from different species, with the resulting recombinant DNA having different properties than the original.

Restriction Enzyme

An enzyme that splits DNA at a specific sequence.

Riot Control Agents

Substances, usually having temporary effects, that are used typically by government authorities for law enforcement purposes.

Toxicity

Toxoid

A measure of the harmful effect produced by a given substance on a living organism.

Toxins

Poisonous substances produced by living organisms.

A toxin biologically inactivated by chemical or physical means, usually for vaccine production purposes. Because a prerequisite for toxoid generation is toxin production, the technology involved has applicability to BW.

V-Series Nerve Agents

A class of chemical agents developed in the 1950s that act by inhibiting a key nervous system enzyme. They are generally persistent and have a moderate to high toxicity. Examples are VE, VG, VM, VS, and VX.

Volatility

Virus

Vaccine

A substance administered to induce immunity in the recipient.

Vesicant

A blistering agent.

Virulence

The capacity of a microorganism to produce disease. A submicroscopic infectious agent that is characterized by a total dependence on living cells for reproduction and that lacks independent metabolism.

A measure of how readily a liquid will vaporize.