Verification Provisions of the Chemical Weapons Convention and Their Relevance to the Biological Weapons Convention

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In crafting a compliance monitoring protocol for the Biological and Toxin Weapons Convention (BWC), the Ad Hoc Group of BWC member states meeting in Geneva has looked to the verification provisions of the 1993 Chemical Weapons Convention (CWC) for guidance. At first glance, the two treaties have much in common, since they both require the elimination of existing stocks of warfare agents and prohibit their acquisition in the future.[1] Both treaties must also address the challenge of distinguishing the production of chemical or biological weapons from the peaceful applications of industrial chemistry and biology. In view of these similarities, some countries favor adopting the basic elements of the CWC verification regime in the BWC compliance protocol.

At the same time, however, important differences between chemical and biological weapons limit the applicability of CWC verification measures to the BWC. The fact that certain microbial and toxin agents are highly potent per unit weight means that a militarily significant quantity is measured in kilograms, compared with tons for chemical nerve agents. Moreover, whereas production of a chemical arsenal requires a fairly large industrial plant, a stockpile of biological or toxin agents could be produced to order in a pilot-scale facility over a period of weeks. For these reasons, the threshold for militarily significant cheating, or "treaty breakout," is considerably lower for the BWC than for the CWC. Finally, the ambiguities between offensive and defensive research on infectious agents and the lack of well-defined indicators of biological or toxin agent production make it more difficult to distinguish between "treaty-prohibited" and "treaty-permitted" activities at dual-capable biological facilities. For this reason, assessing intent is as important as physical evidence in determining BWC compliance. Table 3 describes the differences between chemical and biological weapons and shows where these differences complicate BWC compliance monitoring.

In the following report, major verification provisions of the CWC and their applicability to the BWC are reviewed. Taken together, the various elements of the CWC verification regime provide a useful model for a workable BWC compliance protocol. Depending on the specific issue, however, the CWC model is sometimes readily adaptable, sometimes in need of adjustment for the

[1] Under the BWC, all biological and toxin warfare agents, munitions, and specialized delivery systems were to have been destroyed or diverted to peaceful purposes within nine months after the treaty's entry into force on 26 March 1975. Countries that accede to the BWC after that date must destroy their stockpiles as soon as possible. CWC members must eliminate their existing stockpiles of chemical weapons, if any, within 10 years, with the possibility of a five-year extension in exceptional cases. The CWC also requires the destruction or conversion of former chemical weapons production facilities.

BWC context, and sometimes incapable of meeting the unique challenges of monitoring biological weapons activities.

Table 3: Technical Differences Between Chemical and Biological Weapons and Implications Thereof for BWC Compliance Monitoring.

Parameters	Chemical Weapons	Biological Weapons	Implications for BWC Monitoring
Agent types	Man-made toxic chemicals that do not exist in the natural environment.	Pathogenic microbes and toxins produced by living bacteria, plants, and animals.	Disease agents can be cultivated for legitimate purposes, such as vaccine production, complicating the process of BWC compliance monitoring.
Range of agents potentially suitable for military use	Relatively few chemicals have the necessary toxicity and physical properties, but the development of novel agents is possible.	The range of potential agents is nearly unlimited because of the occasional emergence of natural diseases and the potential for genetic manipulation of microorganisms and toxins.	The broad, purpose-based coverage of the prohibitions in Article I of the BWC (the "general-purpose criterion") must be preserved.
Militarily significant quantity of agent	80 to 1,000 metric tons of chemical agent, depending on type and lethality.	Kilograms to tens of kilograms of agent, depending on type and lethality.	Militarily significant production of biological and toxin agents in small-scale facilities may elude detection. Stockpiles may also be small enough to permit easy concealment.
Stockpiling requirement	Must be stockpiled in multi-ton quantities in stabilized or binary form, or produced in large volume prior to use.	Militarily significant quantities of agent can be produced to order in a few days or weeks, obviating the need for long-term storage.	Dual-use production facilities such as vaccine plants may have a "latent" capacity to produce biological agents in wartime.
Peaceful medical applications of agents and materials	Very small quantities of some Schedule 1 chemicals (e.g., nitrogen mustard, saxitoxin, ricin) are used in biomedical research and medical therapeutics.	Microbial pathogens may be grown in large quantities for the production of vaccines. Also, natural toxins such as botulinum and ricin are increasingly used in medical therapeutics.	Production of microbial pathogens and toxins for legitimate medical uses may serve as a cover for acquiring a biological-weapons capability.

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Specific precursor materials	Chemical-warfare agents are made from a limited number of precursor chemicals that must be imported or synthesized. A few industrial chemicals (e.g, chlorine, phosgene, hydrogen cyanide) were used as chemical weapons in World War I.	Microbial seed cultures and nutrient growth media are widely available from commercial or natural sources. No precursor materials or feedstocks are used solely for production of biological warfare agents.	Since so many microbial and toxin agents are available from natural sources (e.g. diseased animals or castor beans), controlling the availability of seed cultures and source materials is extremely difficult.
Input-output ratio of precursor materials to product	The volume of chemical precursors is directly proportional to the amount of agent produced.	A small quantity of seed culture can be cultivated in a fermentor into a large quantity of agent.	Imposing threshold limits on quantities of biological precursor materials or products is not a feasible monitoring approach.
Size of production facilities	A full-scale chemical agent production facility would require a fairly large industrial site.	If continuous-flow fermentors were used, a biological agent production facility could be confined to a small warehouse building.	Clandestine production of biological agents is hard to detect without human intelligence (e.g., reports from defectors or spies), which tends to be unsystematic and fortuitous.
Dual-use production equipment and ease of converting commercial facility to illicit production	Nerve-agent production requires corrosion-resistant vessels and special containment and ventilation systems, although some countries may cut corners on worker safety and environmental production. Conversion of a pesticide plant to nerve-agent production would take several weeks.	Fermentation equipment used to make vaccines, antibiotics, and other legitimate products can be converted to production of warfare agents. Biocontainment measures are advisable but not essential, assuming vaccination of plant workers. Conversion of a vaccine plant to biological agent production would take about a week, or periodic production could occur in an ostensibly civilian facility.	Intent to produce biological weapons cannot be easily inferred from dual-capable production capabilities. Moreover, supply-side approaches such as nonproliferation export controls are unlikely to be effective over the long-term.
Size of relevant commercial industry	Dual-capable production facilities are ubiquitous in a very large, worldwide chemical industry.	Dual-capable facilities are ubiquitous in the rapidly expanding, worldwide pharmaceutical and biotechnology industries.	Monitoring all potentially relevant dual-capable production sites would be difficult given limited financial and human resources.

Parameters	Chemical Weapons	Biological Weapons	Implications for BWC Monitoring
Need for containment measures at production facilities	Specialized containment measures and ventilation systems are required only for the final stage of live agent production. These demands can be reduced through production of binary warfare agents.	Containment is needed primarily for steps that generate agent aerosols, such as drying and milling. The US and British production programs in the 1950s and 1960s used rudimentary containment, and in the early 1990s, Iraq took minimal precautions.	Biocontainment facilities (at Biosafety Level 3 or 4) are not required for the acquisition of an offensive biological-warfare capability and hence are not a reliable indicator of illicit activities. However, all high-containment facilities that work with dangerous pathogens should be declared and monitored, especially those under military control.
Proprietary sensitivity of dual-use facilities	Most chemical products are not highly proprietary. Industry's main concern is protection of unpatented or non-patentable manufacturing processes.	Genetically engineered microorganisms, new drugs, and manufacturing process steps are highly proprietary, and large sums of money are at stake in their protection.	A BWC compliance protocol will require extensive measures and procedures to safeguard confidential proprietary information.
Physical forms of agent suitable for delivery	Chemical agents may be delivered as a liquid mist, vapor, or aerosol, or adsorbed onto a fine powder ("dusty" agents). Droplet size varies depending on the volatility of the agent and its ability to penetrate the skin.	Microbial and toxin agents generally cannot penetrate intact skin and would be inhaled, ingested, or injected. Only microscopic particles are retained in the lungs. Large-area coverage would require delivery as a particulate aerosol of dried agent (powder) or wet agent (slurry). Dry agent is much easier to aerosolize than wet agent.	Delivery of a biological or toxin agent as a respirable aerosol is the only effective means of inflicting mass casualties. Equipment for drying microbial cultures (e.g. freeze-driers or spray-driers), or the presence of aerosol chambers for testing agent dissemination, may be telltale signs of weaponization.
Delivery systems	Artillery shells, bombs, mines, rockets, missile warheads, and aerial sprayer systems mounted on low-flying tactical aircraft or drones.	Bombs and missile warheads containing low-explosive bursters (with or without specialized submunitions), and aerosol generators mounted on vehicles, ships, aircraft, drones, or cruise missiles.	Highly specialized delivery systems are not a prerequisite for a weaponized biological-warfare capability. For example, agricultural sprayers for dissemination of bacterial pesticides could be modified to generate respirable aerosols of biological warfare agents.
Environmental persistence of agent residues or degradation products	Distinctive degradation products of blister and nerve agents tend to persist in the environment for weeks and in some cases, for years.	Microbial and toxin agents generally persist for hours to weeks. Some agents may be identical to indigenous pathogens or toxins already present in the environment.	Investigation of biological-weapons use is complex, since it requires distinguishing natural disease outbreaks from deliberate or accidental release of biological warfare agents.

Parameters	Chemical Weapons	Biological Weapons	Implications for BWC Monitoring
Availability of analytical methods to detect illicit agents	Known chemical-warfare agents can be reliably detected and identified with analytical techniques such as combined gas chromatography and mass spectrometry.	Each microbial or toxin agent requires specific antibodies or DNA probes for detection. However, biotechnology may offer ways to develop genetically modified agents that are undetectable through routine testing. Some agents (e.g. anthrax) may also be present naturally in the environment in low concentrations, complicating the interpretation of results.	Sampling and analysis for biological warfare agents requires advance knowledge of which agents are likely to be present. Control samples may also be required to rule out natural sources of contamination. Still, the potential for false-positive or false-negative results means that evidence obtained by sampling and analysis must be corroborated with information from other sources, such as interviews, visual inspection, and audits of production records.
Ability to clean up a production facility to prevent detection of illicit agent(s)	Because of the durability and persistence of the carbon-phosphorus bond characteristic of nerve agents, a thorough clean-up of a nerve-agent production facility to remove all traces of contamination is difficult.	A dual-capable facility such as a vaccine plant could be cleaned manually in about 8 hours or with clean-in-place systems in only a few hours. Even so, thorough cleaning may require the disassembly of fermentor systems. Also, residual DNA molecules may be detectable with advanced analytical techniques even after routine sterilization.	The shorter the advance warning prior to a challenge inspection of a suspected biological-weapons production facility, the greater the probability that clean-up will be incomplete and the inspectors will detect traces of illicit agents.

Conclusions

Because of the many technical differences between chemical and biological weapons and their methods of production, the wholesale transplant of measures from the CWC verification regime to the BWC protocol is not appropriate. Despite this caveat, however, several elements of the CWC verification regime, as shown in Table 5, are relevant to the BWC compliance protocol. Like the chemical treaty, the BWC protocol should establish a set of mutually reinforcing measures ranging from facility declarations to on-site inspections. In addition, the BWC protocol should adopt a CWC-like system of "carrots" and "sticks" to reward states that comply with the treaty while punishing those that remain outside or that fail to adhere to its provisions.

Although there are limitations on the effectiveness of on-site activities, a combination of short-notice routine visits to high-risk facilities and occasional challenge inspections would create a useful deterrent effect. Combining the obligation to declare relevant facilities with the obligation to accept challenge inspections at any site, declared or undeclared, would force potential BWC

violators into a quandary.[2] While declaring a relevant facility would make it potentially subject to a routine inspection, not declaring the facility would increase the risk of being caught red-handed during a challenge inspection. Thus, an integrated regime of this type would be stronger than the sum of its parts.

Other conclusions from the previous analysis are as follows:

- To avoid creating legal loopholes that could invite circumvention, nothing should be done to limit or qualify the broad prohibitions contained in Article I of the BWC.

- Proposals to establish absolute quantitative ceilings for the possession of biological or toxin agents are not technically feasible, either for countries as a whole or particular facilities.

- Mandatory declaration of dual-capable facilities is essential for BWC compliance monitoring, but no single criterion is sufficient to determine which facilities should be declared. Instead, a combination of criteria should be employed, with the aim of identifying a subset of "high-risk" government and commercial facilities.

- Challenge inspections of suspect sites should ideally be conducted with no more than 24-hours notice, to increase the probability of detecting traces of illicit production.

- To safeguard national security and proprietary information unrelated to BWC compliance, the protocol should incorporate measures to screen inspectors and hold them accountable for protection of privileged information, guard against frivolous or abusive challenge requests, and allow sensitive facilities to manage access during inspections.

- Although sampling and analysis will be more problematic under the BWC than the CWC, techniques are available to allow inspectors to analyze samples on site without compromising proprietary information.

- The BWC compliance protocol should specify procedures for investigating allegations of use and unusual outbreaks of disease, with guaranteed access to all relevant areas.

- A dedicated, separate BWC monitoring agency will be required to implement the compliance protocol, including processing data declarations and conducting on-site inspections. This small agency should be located in The Hague so that it can share administrative and support services with the OPCW.

- After the BWC protocol enters into force, biological export controls should be implemented in a highly targeted manner to minimize restrictions on dual-use biotechnologies important for the public health, agriculture, and economic growth of developing countries.

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[2] ter Haar, "Indirect Verification," 9.

Today, both the CWC and the BWC are at delicate turning points that could lead either to a significant strengthening of the international norm against these heinous weapons or to the weakening of one or both treaties and an acceleration of chemical and biological weapons proliferation. The CWC entered into force on 29 April 1997 and more than 105 countries are now parties. Already, the CWC's inspectorate has sifted through masses of information contained in data declarations and conducted over 100 inspections. Practical experience being gained through the implementation of the CWC verification provisions should offer useful lessons for the negotiators crafting the BWC compliance protocol.

More broadly, the fate of the chemical and biological disarmament regimes are linked. The emergence of serious problems with CWC implementation could discourage states from attempting to create a strong verification regime for the BWC. Conversely, successful implementation of the CWC would build confidence in the arms control process and give new impetus to the BWC protocol negotiations.