TECHNICAL MEANS OF VERIFYING CHEMICAL WEAPONS ARMS-CONTROL AGREEMENTS

Franklin E. Walker
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and
Convention on the Prohibition of Chemical Weapons
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The impact of technological change on the stability of the military balance and the risk of war has long been debated by military analysts and practitioners. Often, a presumption is made that the effects of scientific advances on these problems are invariably negative. That assumption stems primarily from the single most important advance in military technology of our time—the development of nuclear weapons. Ballistic missiles have compounded that perception by making strategic war swift as well as catastrophic. In the abstract, however, technology is neither necessarily “good” nor necessarily “bad.” The fruits of scientific research can be applied either for “good” or “bad” purposes. The challenge is to channel technological change in the right directions: in the field at issue, toward stability and a reduced risk of war.

In fact, during the postwar period, technological advances have made important contributions to our ability to limit armaments and reduce the risk of war. Examples would include controls on nuclear weapons, such as electronic locks and command systems, which are far more secure now than in the past. Photoreconnaissance satellites and other national technical means of intelligence represent a second example; these systems not only enable a nation’s leader to have greater confidence in his or her knowledge of the capabilities and actions of potentially hostile countries but also make possible the far-ranging types of arms-control agreements now being discussed by the United States and the Soviet Union.

There are other ways that new technologies potentially could be used to reduce the risk of international conflict and to facilitate arms limitations. To help uncover such new ideas and promote their development, The Johns Hopkins Foreign Policy Institute in 1985 organized a project on Technology and the Limitation of International Conflict. Cochaired by Senator William Cohen and Congressman Les Aspin, the project’s executive committee includes eighteen former senior defense and intelligence officials and experts in relevant scientific and engineering disciplines. The group has been examining a variety of proposals ranging from additional means of safeguarding nuclear weapons, to methods for avoiding international incidents in space, to a scheme for the cooperative use of remote sensors to avoid surprise attacks in Europe.

The committee has given special attention to technical means to help verify compliance with possible international agreements to limit chemical weapons.
The United States proposed a comprehensive draft treaty in the Conference on Disarmament in Geneva in 1984, and considerable progress has been made since in the negotiations. Difficult issues remain to be resolved in the talks, however. The most important pertain to the specific procedures that would be incorporated in the treaty to enable signatories to verify compliance with the agreement.

At the same time, there is compelling evidence that the U.S. government has not pursued its own planning for verifying the prospective agreement as vigorously as it should. Specifically, it appears that potential technical means of supporting verification arrangements have not been developed. Such technical means would be required to enable on-site inspections of alleged violations of the agreement to detect and identify prohibited chemical agents. They also would be necessary to help verify the destruction of existing stocks of prohibited agents and to ensure that any production of such agents as may be permitted by the agreement would not exceed agreed upon quantities. Moreover, there is at least some possibility that certain types of tamper-resistant remote sensors might be used to reduce requirements for on-site inspections by foreign personnel. By reducing the frequency, duration, or intrusiveness of required human inspections, such technical devices could ease the difficulty of negotiating the treaty.

The executive committee’s examination of this subject has included a survey of relevant technologies and their possible applications to the verification of compliance with chemical weapons arms-control agreements contained in this policy brief. In addition, the committee has been briefed by representatives of several government-sponsored research and development centers and has discussed the current status of efforts to develop these technical means of verification with relevant officials of the Department of Defense. Based on these discussions the committee has concluded that a concentrated, multiyear research program should be initiated by the U.S. government, with the purpose of developing instrumentation to satisfy the various requirements of verifying chemical weapons treaties.

The following brief was written by Franklin E. Walker of the University of California’s Lawrence Livermore National Laboratory. The project has found Mr. Walker’s assistance very helpful and is pleased to publish his views. They should not, however, be attributed necessarily either to the Foreign Policy Institute or to the members of the executive committee of the project on Technology and the Limitation of International Conflict.

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TECHNICAL MEANS
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In the past several years there has been an alarming resurgence in the use of chemical weapons. The chemical attacks by Iraq on Iranian troops in 1985 is one example. The apparently indiscriminate use of chemical warfare (CW) agents by the Soviet Union in Afghanistan is another. It also has been alleged that Vietnam has used toxins in both Laos and Cambodia. Moreover, analyses of Soviet activities in the CW field indicate that the Soviets have stockpiled large quantities of CW agents and are prepared to conduct warfare in a chemical attack environment.

These considerations, together with the continuing spread of capabilities to produce chemical agents among Third World countries, have convinced the U.S. government that a verifiable treaty to prohibit the production and use of chemical agents, and to require the destruction of existing stocks, would be desirable. In fact, one of the few concrete agreements reached by President Ronald Reagan and General Secretary Mikhail Gorbachev at their first summit meeting in Geneva in November 1985 was that new efforts should be directed toward the negotiation of a CW treaty, and some substantive progress has been made since.

Negotiations for a new general CW treaty have been under way for many years in the Conference on Disarmament (CD) at Geneva, but until recently progress has been disappointingly slow. Of primary concern is the ability of the United States to verify compliance with any treaty negotiated. A major impediment to more rapid progress has been the Soviet Union’s rejection of the specific on-site inspection procedures proposed by the United States. The USSR has accepted in principle the need for on-site inspections, however, and there has been some movement in the talks. Even so, the problem of reliable verification goes beyond these specific disagreements and derives in part from deficiencies in the preparations made so far by the United States for verifying a CW treaty. There appears to be a consensus among several government agencies that even if the U.S. proposals were accepted fully by the USSR, the detection and analysis capabilities that would be available to the United States for monitoring compliance with a CW treaty would be distressingly inadequate.

This brief addresses the urgent problem of the United States’ capability to monitor compliance with a CW treaty and explains how the nation could develop instrumentation and procedures to achieve an effective monitoring capability.
consistent with the Convention on the Prohibition of Chemical Weapons proposed by the United States. Specifically, it (1) describes relevant aspects of the proposed convention, (2) summarizes the recent negotiations on verification and monitoring issues, (3) describes relevant technologies and their derivative instruments and devices that could be used to help monitor provisions of the convention, and (4) assesses the risks and liabilities in using the suggested monitoring capabilities. It concludes by recommending a U.S. commitment to verification research and development. The details of a specific plan for developing the required monitoring instrumentation and procedures and for their testing, evaluation, and coordination is left to appropriate executive and congressional agencies.

The CW convention lists specific "permitted purposes" for which designated chemical agents and precursors may be used legitimately.

THE U.S. CW CONVENTION PROPOSAL

On April 18, 1984, the United States presented to the Conference on Disarmament its proposed Convention on the Prohibition of Chemical Weapons (see appendix). This convention is built on, but extends, two earlier documents that failed to provide for effective monitoring or verification: the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed in Geneva on June 17, 1925, and the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, signed in Washington, London, and Moscow on April 10, 1972. This section summarizes the key provisions bearing on the proposal's verification requirements. If the United States is to have confidence that the terms of the treaty are being complied with by the other signatories, most important, by the USSR, it will have to develop unilateral means and negotiate effective cooperative procedures to monitor compliance with those specific provisions. The technological devices that could be utilized to support these unilateral and cooperative verification procedures are surveyed in the next section of the paper.

The basic prohibitions, contained in Article I, state,

Each Party undertakes to:

(a) develop, produce, otherwise acquire, stockpile, or retain chemical weapons, or transfer chemical weapons to anyone;
(b) conduct other activities in preparation for use of chemical weapons;
(c) use chemical weapons in any armed conflict;
(d) assist, encourage, or induce, directly or indirectly, anyone to engage in activities prohibited to Parties under this Convention.

The broad commercial usage of many of the precursor chemicals that also can be utilized to produce CW agents complicates the verification regime of the convention. Therefore, the convention lists specific "permitted purposes" for which designated agents and precursors may be used legitimately. They include "industrial, agricultural, research, medical or other peaceful purposes; protective purposes; and military purposes that do not make use of the chemical action of a toxic chemical to interfere directly with normal functioning of man and animals so as to cause death, temporary incapacitation or permanent damage." "Protective purposes" in this context means purposes directly related to the acquisition of protection against chemical weapons. The retention, production, acquisition, and use of super-toxic* lethal chemicals and key precursors for such protective purposes are strictly limited by the convention to those amounts that could be justified for such purposes. At no time, moreover, may the aggregate amount of super-toxic chemicals or precursors exceed one metric ton, nor may the aggregate amount acquired in any calendar year exceed one ton.

The proposed convention further requires that all stocks, production facilities, and past transfers of chemical agents be declared and that parties make an annual declaration of all key precursor and toxic chemical stocks devoted to protective purposes. All stocks and facilities listed on this declaration and not permitted by the convention must be destroyed.

In addition, the convention provides for a Consultative Committee with the responsibility to:

- carry out systematic international on-site verification, through on-site inspection and monitoring with on-site instruments, of:
  - chemical weapons,
  - destruction of chemical weapons,
  - closure and destruction of chemical weapons production facilities,
  - permitted single specialized facilities for production of super-toxic chemicals,..., and
  - production for permitted purposes... .

The parties are required to allow continuous monitoring with on-site instruments and the presence of inspectors during the actual destruction process, and they must agree not to interfere with the conduct of any of the approved monitoring procedures.

Further provision is made for a Fact-Finding Panel to be appointed by the Consultative Committee; each member of the panel has the right to request at any time a "special on-site inspection" of any party to the convention. Within forty-eight hours of such a request, the party to be inspected is required to provide the inspection team unimpeded access to the designated subject location or facility. Additionally, each party has the right to request an "ad hoc inspection," which if approved in twenty-four hours by the Fact-Finding Panel, will commence within the next twenty-four-hour period.

Some of these provisions of the proposed convention, of course, may be changed substantially or dropped altogether during the negotiations; some countries have taken strong exception to some items. In this brief, however, it is assumed that the final convention will not differ greatly from the current draft and, particularly, that on-site monitoring will continue to be considered absolutely essential to maintain confidence in compliance with the articles of the convention. In view of the strong stand that the United States has taken on the need for effective verification, this assumption is eminently reasonable.

*The super-toxic lethal chemicals are defined in the convention as those "which have been stockpiled as chemical weapons or which pose particular risk of such stockpiling." Other dangerous chemicals are listed that pose a particular risk of diversion to chemical weapons purposes.
SUMMARY OF RECENT NEGOTIATIONS ON VERIFICATION ISSUES

Both bilateral and multilateral negotiations on the CW convention are being carried out in the Conference on Disarmament. Former U.S. Ambassador Donald L. Luevitz summarized the status of the negotiations at the end of 1986 and identified the major unresolved negotiating issues requiring prompt attention: (1) declaration and monitoring of chemical weapons stockpiles, (2) elimination of chemical weapons production facilities, (3) prevention of the misuse of the chemical industry for chemical weapons production, and (4) challenge inspection.

In addition, several special efforts by individual countries that are participating in the CD have been concluded in 1986 and have helped define approaches to overcoming difficulties in verification. First, for example, The Netherlands convened a workshop on the Verification of a Chemical Weapons Ban on June 4–6, 1986. The primary focus of this workshop was to review the results of an experimental on-site inspection conducted by The Netherlands to verify the nonproduction of chemical weapons in a large chemical production complex and to develop and evaluate procedures for such inspections that should be required by the convention. The company area where the “experimental inspection” was conducted included a variety of petrochemical and multipurpose chemical production facilities, the largest of which was selected for the exercise. The facility is used to produce an organophosphate pesticide which contains trimethyl phosphate, trimethyl phosphate also could be a precursor for the production of chemical weapons.

The aim of the experimental inspection was “to study and test organizational and technical aspects involved in routine inspection of a chemical plant under a CW convention.”** The workshop made these preliminary conclusions: verifying that prohibited agents are not being produced may be possible at acceptable costs, but no single procedure would suffice for all plants; inspectors should visit the plants to be made familiar with plant operations; and inspectors must be highly qualified. The participants in the experimental inspection from the chemical plants were said to be cooperative.** Although this experiment in no way solves all the problems of commercial plant inspection, it is an encouraging first step in the study of this difficult problem.

Second, the Norwegian delegates to the CD reported the results of a six-year study on verification of the alleged use of chemical weapons in a variety of weather conditions, but particularly in snow. The main thrust of this work was to develop satisfactory sampling procedures so that integrity of the samples could be maintained and the CW agents could be analyzed successfully. Third, the delegation from Belgium reported a study on scheduling the destruction of chemical weapons in accordance with the proposed convention.


**Australian government representatives, in cooperation with officials of the Australian chemical industry, also conducted and evaluated a trial inspection similar to the study presented at The Netherlands workshop.

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While some progress thus has been made toward overcoming the difficulties of monitoring treaty compliance, the problem of effective verification continues to be compounded by several considerations. Among these are:

Availability of chemicals. Many of the precursor chemicals used in the manufacture of CW agents are produced and transported in very large quantities in many countries for permitted commercial uses (herbicides, insecticides, pharmaceuticals, and so on).

Availability of production facilities. The plants in which CW agents are, or can be, produced also can be used for the production of many permitted chemicals, and certain types of permitted commercial plants also could produce CW agents.

Extent of monitoring requirements. There are a great number of permitted commercial chemical production plants, which would require extensive monitoring capabilities to ensure that prohibited agents were not being produced.

Toxicity. Chemical warfare agents obviously are extremely toxic, but so too are many permitted chemicals. The special industrial prophylactic procedures required at plants producing permitted toxic agents would make on-site inspections and monitoring more difficult.

Chemical instability. Some CW agents are somewhat unstable chemically when deployed in the field, making their detection and unambiguous identification difficult; inspectors would need to be on site within hours to days of an illegal CW use to be able to demonstrate that a violation had occurred.

Lack of necessary instrumentation. The portable, rugged, reliable instrumentation required for effective, practical, on-site monitoring has not yet been developed, so it is not yet known if it will perform adequately in a variety of inspection procedures.

Nevertheless, recent developments suggest that significant progress toward verification of treaty compliance could be made in the near future by a coordinated and well-directed effort. Independent accomplishments pertinent to parts of this problem have been made in many countries—Canada, Finland, Germany, The Netherlands, Norway, Sweden, Switzerland, and the United States. Chemical and biochemical techniques have been demonstrated by European and North American researchers to be effective in both detecting and analyzing chemical agents. The Chemical Warfare Review Commission, appointed by President Reagan in March 1985, has focused renewed attention on the unsatisfactory CW posture of the United States,* which should add to the determination of government officials to correct deficiencies and to become prepared to monitor a CW treaty effectively.

Recent developments suggest that significant progress toward effective verification could be made by a coordinated and well-directed effort.

If the United States is to be prepared to monitor a CW treaty, however, it is essential that the government launch a forceful effort to stimulate additional research and development of verification and monitoring capabilities and to

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coordinate such measures with the treaty negotiations. The U.S. CW communi-
ty should be tasked to develop specific procedures and instrumentation that
will provide effective monitoring capabilities consistent with all aspects of the
current draft convention, and with future amended drafts as the negotiations
progress. Negotiators and those who develop these procedures and instrumen-
tation should cooperate closely to ensure that the provisions that are ultimately
negotiated can be monitored satisfactorily. They must insist that pertinent tech-
nologies be used to develop simplified, rugged, accurate, and reliable monitor-
ing instruments whose availability can support and facilitate negotiations.
This instrumentation must offer the necessary verification capability without divulg-
ing proprietary or sensitive information, and without providing unwanted
transfers of American technology abroad. In addition, the United States must
define the baseline levels of confidence it can expect from each specific monitor-
ing capability. Therefore, any instrumentation developed must be tested against
the requirements of realistic monitoring scenarios.

The United States can, through a focused research and development program,
device equipment and testing such that the levels of confidence in both pro-
cedures and equipment can be evaluated. By mobilizing technologies now
available for CW treaty monitoring, and the required scientific personnel and
facilities, America can make an initial, viable step toward the goal of effective
dismantlement in the CW arena. These technologies, and their applications, are
described in the next section.

TECHNOLOGIES POTENTIALLY USEFUL IN MONITORING A
CW TREATY

In an attempt to develop procedural and technical options for compliance moni-
toring of the proposed CW convention, the U.S. Army Chemical Research,
Development and Engineering Center hosted a Chemical Weapons Treaty Compliance
Verification Workshop in 1985. The group of experts established monitoring in-
spection scenarios and assessed the instrumentation and technologies required
to conduct effective monitoring in each. Also, rough levels of confidence in moni-
toring results were projected. As shown below, the group’s findings confirm that
the United States has the potential means to monitor effectively a CW treaty.

This section first lists those specific items in the proposed CW convention that
the army verification workshop determined would require monitoring and in-
spection. It then surveys the technologies that could be used in carrying out
such compliance monitoring. Finally, it explains the possible applications of
relevant technologies in specific inspection scenarios. The technology survey
includes instruments currently, or soon to become, available from U.S. and
foreign research organizations, as well as those that are still being developed.
Where appropriate, novel concepts that would require considerable research
and development are also mentioned.*

*Footproof tags for containers, physical security networks of pressure, temperature, motion and distance
sensors, and video monitors could be helpful in monitoring a variety of arms control agreements. These
types of devices already are fully developed, readily available, and already in use for a variety of pur-
poses. They will not be discussed further in this brief; nor will the administrative and procedural re-
quirements for initiating and conducting inspections, the physical protection required for inspectors,
or the decontamination technologies.

PROVISIONS REQUIRING MONITORING OR INSPECTION

1. Declared chemical agents and precursor stocks
2. Declared agent production facilities
3. Single permitted CW production facility
4. Special on-site inspections (Article X, CW convention)
5. Ad hoc on-site inspections (Article XI, CW convention)
6. Demilitarization of stocks
7. Agent facilities destruction
8. Movement of stocks to demilitarization sites
9. Chemical training exercises for defensive purposes
10. Commercial chemical production
11. Transport of permitted quantities of CW agents
12. Nonpermitted use of chemical weapons (warfare, terrorism, and so on)

IR spectroscopy can provide a high degree of accuracy in identifying
chemical compounds for which “library sample” spectra are available.

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Infrared (IR) Spectroscopy. This analytical method can provide a high degree
of accuracy in identifying specific chemical compounds for which “library sam-
ple” spectra are available. The sample to be analyzed must be reasonably pure
(> 95 percent), and a fairly large sample (10-20 mg) would have to be obtained
for confident results. To make this method readily usable for verification
monitoring, moreover, there must be improvements (ruggedness and miniaturization) in the portability of the instruments, and a computer library of the spectra of specific chemical agents, precursors, decomposition products, and pertinent chemical reactive combinations of agents must be prepared. This infrared system could be automated and computer controlled for on-site inspections and easy use in the field. Infrared spectrometers can be made smaller and more portable than mass spectrometers.

Fourier-Transform-Infrared (FT-IR) Spectroscopy. This infrared system has the advantage that it can operate effectively with a somewhat smaller and less pure sample than the HR spectrometer, but it probably would not be significant.

Gas Chromatography. This type of analysis can be used to help determine the quantities of various components in a mixture, as well as to help identify these specific compounds in a mixture for which chromatography can be available. It can also purify samples. Single-channel chromatography cannot be relied upon for definitive identification, but there is available from Nordion of Finland a dual-channel, high-performance instrument that would be more reliable than single-channel systems. The Norwegians, for example, have used chromatographic procedures in their field exercises to collect and purify small samples of CW agents. Some chromatography systems now available are portable, but adaptation for use in field inspections would require additional development. A number of useful variants of chromatography also exist, including liquid systems, gas capillary models, and flat plate absorption techniques that have varying capabilities for purifying samples, working with small samples, identifying compounds, and making quantitative analyses.

Tandem Mass Spectrometry (MS/MS). This analytical system uses two, cooperative mass spectrometers and has excellent sensitivity. It can be used to identify picograms (10^-12g) of a specific material in the presence of a mixture of impurities. Most current systems are relatively large and require a high level of scientific expertise to obtain good analyses. A system that can be transported in a utility van is available from the Seic Company of Canada, however. In addition, development of a more easily portable tandem mass spectrometer has been accomplished by the Bruker-Fraven Company for a system included in a reconnaissance vehicle of the army of the Federal Republic of Germany. This system could be adapted readily for use in CW treaty compliance inspections.

Tandem Gas Chromatography-Mass Spectrometry (GC-MS). This method combines gas chromatography with mass spectrometry. It can provide excellent identification of very small samples, but it presently is a large and complicated system requiring scientific support and operation. It would require considerable development to adapt this system for verifying compliance with a CW treaty.

Nuclear Magnetic Resonance Spectroscopy (NMR). This analytical method involves observation of nuclear spin components in molecular structures. Spinning

NMR would be useful in determining the molecular structure of new or suspected chemical agents.

Coated Piezoelectric Crystal Array Analyzers. The operating principle of this analytic tool is based on the fact that the vibrational frequency of piezoelectric crystals is shifted a measurable amount as chemical agents are adsorbed on polymer coatings on the crystals. By using an array of crystals with different specific polymer coatings, definitive patterns in the frequency shifts can be obtained. When fully developed, these instruments should have the sensitivity to detect ten parts of chemical agent per billion parts of gas with a five- to twenty-second response time.

They can be made very small and portable; an experimental model of about attaches case size has been demonstrated. With computer control and a computer library of relevant chemicals, they could be very useful for on-site inspections. The system is being developed now at the Lawrence Livermore National Laboratory. Recent work with surface acoustic waves on piezoelectric crystals at the Prins Maurits Laboratory in Holland shows promise for very small sensors with high sensitivity.

Coated Fiber Optodes. The operation of these devices is based on a polymer-coated fiber and functions in one of two ways. First, the fiber may change its refractive index as specific CW agents are adsorbed by the polymer. Second, the stress resulting from adsorption may bend a fiber that is bonded on one end so that light passing through the fiber (optode) moves on a measuring scale.

These instruments, which are now being developed, can be made as small as a pack of cigarettes. They can be used for the specific identification and some quantitative analysis of CW agents, precursors, and decomposition products. Their small size would potentially make them very useful in on-site challenge inspections. Both the polymer-coated crystals and the optodes also could be useful to the military services as CW warning sensors and for CW stockpile monitoring sensors.

Immunosensor. A breakthrough has occurred in the capability, ease of use, and field compatibility of antibody methods of analysis, by combining three separate technological advances: monoclonal antibody technology, fluorescent waveguide immunosensor, and a non-volumetric rapid immunosensor technique. Thus, it is now possible to develop an antibody assay system that combines the extreme.
specificity of monoclonal antibody techniques with a sensitivity better than picograms (10^{-12} g). These technologies can be used to develop a miniature portable sensing system requiring no perishable fluid reagents, no metering of fluids or any other difficult manipulation under field conditions, and no special operator skill requirements.

Work on this system also is in progress at the Lawrence Livermore National Laboratory. This instrumentation would be excellent for on-site inspections in the field, where very small samples of impure milieux are likely to be found.

Enzymatic Assay. Work that has been done in many fields could lead to an enzymatic assay system, and such a system could very likely be applied to the CW monitoring problem, although much further development effort would be required. This assay system could provide a measurement of the physiological effects experienced by both humans and animals in the vicinity of CW production, use, or contamination, which could reveal the existence of new agents through specific suspected generic responses. It could be very useful in on-site inspections where certain types of previously unknown and therefore uncataloged agents or precursors are suspected. For example, analysis of levels of acetylcholinesterase in a person’s blood, or differences between a person’s hemoglobin oxygen-binding capability and normal levels, could provide evidence of new toxic agents.

Another generic detection scheme would utilize receptors—the physiological targets of the chemical agents in humans. Detectors using receptors would be able to establish the presence of agents not presently known. This capability would match the intent of the proposed convention to monitor chemicals having adverse effects on humans. This, of course, involves monitoring for more than the classical warfare agents.

Association of Selected Instrumentation with Data Links. Unmanned instruments potentially could monitor the destruction of chemical stocks or the production of agents for permitted purposes. Probably any of the instruments and devices described above could be adapted for unmanned use. The mass spectrometers and NMR would be the most difficult to adapt, because of their requirements. Data links would have to be provided to give a prompt alert of possible interference with any unmanned instruments or with the data transmission itself. Appropriate technology appears to be available, but it would need to be adapted to this purpose and tested under simulated field conditions. This could be an expensive project, but it would be an important factor in reducing requirements for a human presence for inspection purposes. There will still be a strong requirement for inspection visits to ensure nonmampering with on-site devices and to allow calibration, repair, testing, maintenance, and other tasks of the devices.

Applications

Several of the convention monitoring requirements can be accomplished by using a similar set of devices or instruments. In the following discussion, monitoring scenarios with similar monitoring or inspection requirements are grouped together.

**Declaration of Existing Stocks and Production Facilities.** The proposed CW convention presently calls for a declaration by each party, within thirty days after the convention enters into force for that party, of all existing chemical weapons, chemical weapons production facilities, and super-toxic lethal chemicals or key precursors for protective purposes and their production facilities. It further requires a general plan for the destruction of all chemical weapons and chemical weapons production facilities, except for a single permitted production facility and chemical weapons permitted for specific purposes.

It appears that the chemical aspects of monitoring and verifying the declaration of chemical agents and precursor stocks, the movement of stocks to demilitarization sites, and the transport of permitted quantities of CW agents would likely be accomplished by use of simple detection and analysis test devices and instrumentation. The chemical agents or precursors in question would be previously identified by the party being inspected, it would appear that verification of the specific identity (and quantity) of the declared items could be made simply with the U.S. Army colorimetric test kits, ACADA, or other technologies, such as dipsticks, coated fiber optic probes, HPLC spectroscopy, mass spectrometry, or the coated piezoelectric crystal analyzer. The feasibility of using these methods has been demonstrated, however, additional efforts to develop the hardware and to improve the portability of some of these instruments and devices are needed. Procedures for the use of such monitoring equipment on-site must be carefully planned in order to ensure the highest possible level of confidence in the results as compared to the monitoring requirements.

For verifying declarations of agent production facilities, the single permitted CW production facility, and destruction of agent facilities (items 2, 3, and 7), again, simple chemical procedures and equipment should be sufficient. The specific agents to be verified would be declared, greatly simplifying necessary tests to identify the specified chemicals as agents and precursors. The instrumentation mentioned in the previous paragraph would apply to these activities as well, although they may not be as important as the administrative and reporting procedures required to ascertain full compliance.

**On-Site Inspections.** More difficult issues are implicit in the requirements to carry out special on-site inspections and ad hoc on-site inspections (items 4 and 5). In these situations there would be a presumption of noncompliance, and it may be assumed that the host party would be uncooperative. Also, it is possible that some previously unspecified or unknown precursor, CW agent, chemical process, or decomposition product might be involved. The instrumentation required thus would have to be more sophisticated technically than that used to verify the destruction of specific types of declared chemical agents, and yet it must still be workable under adverse circumstances—in the field, on short time scales, with smaller and less pure samples, and perhaps in the face of deliberate efforts to deceive, interfere, or intimidate the inspectors.

In addition to the type of detection and analysis equipment and instrumentation just mentioned, it would be useful in carrying out on-site inspections to have portable (by personnel or small vehicle) models of gas chromatographs, as well as tandem mass spectrometers, FTIR and NMR spectrometers, immunoassay, and glass capillary chromatographs. Not all of these instruments...
or methods would be required in each case, but all could be useful in particularly difficult analyses. Considerable development effort will be required to bring some of these instruments to a status at which their use would be feasible in ad hoc or special on-site inspections.

Monitoring the Destruction of Existing Stocks and the Operation of the Single Permitted Production Facility. Monitoring the dismantlement of CW stocks (item 6) and, to some extent, the operation of the single permitted CW production facility (item 5) pose different problems, since the necessary operations may span many years. The draft convention requires that the destruction of chemical weapons begin "not later than twelve months, and finishing not later than ten years, after the Convention enters into force" for each party. To monitor compliance with these aspects of the draft convention, the use of unmanned instruments to monitor on-line processes, including measurement of their pressure, volume, temperature, chemical analytical data, natural gas flow, as well as to analyze decomposition products, would be imperative, so that continuous monitoring by human inspectors might not be needed.

Apparently, data from the instrumentation would need to be forwarded to the Consultative Committee in secure form and in a manner to indicate that no tampering had occurred. Alternatively, the instruments could be programmed so that an alarm would be given via a secure data link to the inspection force of the committee if an indication of noncompliance or tampering were detected. These procedures are yet to be determined. Special tamper-resistant equipment would need to be developed for this purpose and for other scenarios requiring on-site equipment. Computer-controlled process monitors, perhaps using remotely terminated process sensors providing data to a central automated laboratory, should be satisfactory for some purposes.

Some of these monitoring and analysis instruments are currently available, as are some aspects of the computer control and data communication subsystems. Development of an optode system (fiber optics used in chemical and process analysis) now appears feasible, and it could greatly reduce the cost of monitoring the many existing CW sites. A special effort must be included in this development to uncover any inadequacies and to evaluate the likely limits of confidence in the system. The more sophisticated instrumentation called for in connection with ad hoc on-site inspections may not be required for monitoring the destruction of stocks and permitted production, but the monitoring protocol and general inspection procedures required for the latter may be especially difficult to negotiate and carry out.

Monitoring Permitted Exercises and Commercial Chemical Production. Monitoring defensive chemical training exercises and commercial chemical production (items 9 and 10) probably will pose very difficult problems of general inspection procedure. The instrumentation proposed for previous inspection provisions could be used to monitor the chemical aspects of these two operations, but negotiation and implementation of an effective verification protocol may be extremely difficult, and the level of confidence in the monitoring results is uncertain at present.

Monitoring for the Nonpermitted Use of Chemical Weapons. Monitoring nonpermitted uses of chemical weapons (item 12) may be the most difficult task of all, as has been demonstrated to some degree by U.S. attempts to demonstrate conclusively CW deployments in Afghanistan by the Soviet Union and the uses of toxins in Southeast Asia by Vietnam. Validating Iraq's uses of chemical agents, on the other hand, has proved far easier, primarily because the aggrieved party, Iran, was in a position to grant rapid access to the site of the alleged use and cooperated with investigators in other ways as well.

In verifying allegations of the use of prohibited chemical agents, all the chemical detection and analysis equipment and instrumentation proposed for use in on-site inspections, if made sufficiently portable, should be helpful—especially, the immunoassay and enzymatic systems. The medical examination and the biochemical or clinical analysis of alleged victims of chemical warfare also may be useful. The physiological examination of animals, birds, and perhaps plants in the suspect area could be useful as well, but on-site visits would still be imperative. Special problem analysis, sample collection or sample security may add significantly to the verification effort. Rapid access to sites of suspected use is critical in reaching conclusions as to culpability.

Potential Advantages of Remote Sensors

The previous section described how both on-site and remotely positioned sensors could aid in the verification of a chemical weapons treaty. The degree to which remote, unmanned sensors might limit the number and duration of the required on-site human inspections, as well as reduce the need for a continuous human presence during the operation. Computer-controlled chemical warfare detectors, such as the permitted production of chemical warfare agents, is an important question. Although the technologies for a network of temperature, pressure, motion, and distance sensors, as well as video monitors, are available now, research and planning would be required to design site-specific, tamper-resistant networks.

A remote sensing system could be based, for example, on chemical flow monitors connected to a central analytical instrumentation area, where the analysis schedule and the data reporting would be controlled by computers. Combined with computer-monitored and -controlled flow and process sensors (now available), such a system could provide, through secure data links, either continuous or periodic analytic results or a warning signal if production or destruction processes surpassed previously established tolerence boundaries.

Additionally, sensors with very high sensitivity (that is, down to picogram levels), based on coated piezoelectric crystal arrays or the coated fiber-optic instruments, could be used in remote sensing systems. These might be emplaced outside the process areas but within specific buildings, or on or near the external walls of buildings, or possibly on the perimeters of chemical weapons research, production, or storage areas. These sophisticated sensors could be connected to data links (possibly land lines, radio, or satellite) for direct communication with the Consultative Committee facilities. They obviously would need to be tamper-resistant systems. In some cases of materials with monoterror to high-vapor pressure, they may provide real-time warning of the presence of disallowed chemical agents, precursors, or decomposition products of known or suspected agents. It is probable that an immunoassay instrument using appropriate biomaterials also could be developed and incorporated into such a
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detection and warning system to report the presence of specific chemical groups indicating the presence of certain types of chemical warfare agents. Research would be time-consuming, however, and would require an interdisciplinary team. Thus, it appears feasible to develop remotely emplaced sensors from known technology for monitoring the destruction of declared stocks and permitted production, to warn of the presence of CW agents in unauthorized locations, or to detect some new agents. Much development would be required, however, particularly to miniaturize, to increase the ruggedness of these instruments, and also to tailor any single system to a specific site. In addition, it would be necessary to conduct extensive testing and analysis to obtain estimates of the confidence levels obtained with these systems. Remote sensors should reduce the requirements for on-site inspections and a human presence; however, they would not eliminate those requirements.

Possible Spin-Offs from the Technology Developed for CW Verification

The new miniaturized instrumentation and devices that might be developed for CW verification monitoring could be useful in other applications. Some, for example, could be employed with little, if any, modification in monitoring U.S. production, stockpiling, and, particularly, the destruction or demilitarization of chemical weapons. The United States has useful instrumentation now for these purposes, but some novel concepts could be realized from a coordinated research program that would enhance these capabilities. With some minor modifications in software (library) or sampling techniques, this new instrumentation could also be used for safety monitoring in research and production of many hazardous chemicals and other materials used for civilian purposes, although there are sophisticated systems now commercially available from which the CW community has obtained valuable concepts and insights.

Second, an advanced flow and process control system using optodes with one central computer-controlled analytical instrument and communication system, as envisioned for the remote monitoring of the destruction of existing stocks of CW agents, could be adapted to chemical production plants with a high probability of better flow and process control of both local and remote operations at a significant reduction in cost. Third, the military services could benefit from advances in piezoelectric crystal array and coated fiber-optic technologies, as they might be used for the detection and rapid analysis of chemical warfare agents and other noxious gases on the battlefield. They might also be applied as warning sensors on ships and aircraft for the detection of noxious exhaust or other gases.

TECHNICAL MEANS OF VERIFYING CW AGREEMENTS

Fourth, the generic agent detectors could have applications for the general detection of classes of harmful substances or poisons in the atmosphere or other environments.

RISKS AND LIABILITIES

It is apparent that the monitoring of a chemical weapons convention, if one can be negotiated, will be a difficult, expensive, and time-consuming operation. Major aspects of the problem are the ubiquitous production and use of chemicals and the facts that both a large number of commercial plants could be diverted relatively easily to CW agent production and that the precursors for chemical weapons have many innocuous commercial uses. Another crucial factor is that new, lethal chemical agents could be developed fairly readily, so that detection and analysis equipment must be versatile and sophisticated. It would be very important to have generic detectors that could monitor the action of new agents on the physiological receptors in humans. There are important additional concerns. The design of instruments used to monitor a CW agreement must not include critical technologies that the United States wishes to keep secret, as many of these systems may have to be provided to the Consultative Committee for examination or use. This is a serious concern of commercial firms.

Another aspect of verification monitoring of special concern is that challenge or ad hoc on-site inspections could be used by foreign governments as a means to gain access to sensitive U.S. government facilities—for example, nuclear weapons laboratories or production and storage facilities. Since inspection procedures proposed for use by the United States are not published, U.S. policymakers are concerned about the possibility of this double-edged sword.

On-site or remote sensors that are unattended will need to be very cleverly protected to avoid deception and tampering. Although substantive improvements have been made in tamper-resistant systems for nuclear weapons, further work would be required to apply these principles to remote sensors to monitor chemical weapons development, production, and stockpiling activities.

Some have argued that binary chemical weapons, such as those now ready for production in the United States, may make it more difficult to verify compliance with a CW treaty, since no super-toxic chemical agents need to be produced or stockpiled. If other countries produce binaries or certain other novel weapons (wherein more than just the final chemical reaction is completed after weapons launch), this argument continues, verification concerns could be compounded. On the other hand, the Chemical Warfare Review Commission concluded that the U.S. production of binary chemical weapons would not make the negotiation of a "multilateral, verifiable ban on chemical weapons" more difficult. In fact, the commission maintained, the U.S. decision to produce binary weapons may even have helped bring the Soviets to the Geneva negotiations with a more positive attitude.
CONCLUSION

This brief survey of technologies and instruments potentially relevant for verifying compliance with the U.S. draft Convention on the Prohibition of Chemical Weapons makes clear that there exist a number of ways to improve existing capabilities to detect and identify lethal chemical agents whose production, storage, or use might be prohibited by a CW treaty. If additional research and development demonstrated that these technologies could be incorporated in other instruments with appropriate characteristics, the new technologies could be used to help inspectors verify compliance with any CW treaty concluded and, in some cases, to reduce requirements for the frequency or duration of such human inspections. To serve such purposes, development programs must result in highly reliable, portable, and rugged instruments that can be adapted for use in a variety of inspection scenarios, some envisioning their dispatch on very short notice to remote regions of the globe. The greater the flexibility of such instruments in terms of dealing successfully with the range of existing and potential lethal agents, the better. With respect to technologies that might be used in remote (unmanned) sensors, development programs also must ensure that instruments are tamper-resistant and, to the degree possible, that they minimize the degree of intrusiveness required to operate successfully.

The probability that such effective instruments will be developed could be greatly enhanced if the U.S. government were to pursue a coordinated program toward these ends and if it were willing to invest greater research funds toward such an objective. Plans for such a development program have been drawn up by the U.S. Army Chemical Research, Development and Engineering Center in Aberdeen, Maryland, and have already been coordinated with other relevant government agencies. To date, however, the program has not been given a high enough priority to compete successfully for limited budgetary resources.

In this writer’s view, the development of inspection instrumentation and its integration in planning for the verification of possible CW treaties should receive a higher priority. Development of such instruments will require a substantial effort over a sustained period. Critical elements should be in hand before the United States goes very far in proposing the details of inspection procedures to other nations. The initiation of a focused and coordinated research program should receive a higher priority in support of the United States’ objectives in the Geneva negotiations.

A broader issue also is suggested here. The U.S. government’s inability or unwillingness to allocate funds for the development of improved means of verifying chemical weapons treaties is replicated in other arms-control negotiations. One exception is negotiations on limitations on nuclear weapons testing; total government spending on verifying nuclear test bans, including satellite monitoring and the development of seismological monitoring methods, has already reached a level of about $100 million per year. Still, this is the only exception. It seems reasonable that comparable expenditures should be devoted to the development of means to vordy limits on chemical weapons, nuclear delivery systems, and the other weapons for which the United States is already engaged in serious negotiations.

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APPENDIX

CONVENTION ON THE PROHIBITION OF CHEMICAL WEAPONS

Draft treaty proposed by the United States at the Conference on Disarmament, April 18, 1984
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CONVENTION ON THE PROHIBITION OF CHEMICAL WEAPONS

The States Parties to this Convention,

Reaffirming their adherence to the objective of general and complete disarmament under strict and effective international control, including the prohibition and elimination of all types of weapons of mass destruction,

Desiring to contribute to the realization of the purposes and principles of the United Nations, as set forth in its Charter,

Recalling the significance of the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, and also of the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, signed at Washington, London, and Moscow on 10 April 1972, and calling upon all States to comply strictly with the said agreements,

Determined, for the sake of all mankind, to exclude completely the possibility of toxic chemicals being used as weapons,

Convinced that such use would be repugnant to the conscience of mankind and that no effort should be spared to minimize this risk,

Considering that achievements in the field of chemistry should be used exclusively for the benefit of mankind,

Convinced that the complete and effective prohibition of the development, production and stockpiling of chemical weapons, and their destruction, represents a necessary step towards the achievement of these common objectives,

Fulfilling the commitment under Article IX of the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction with regard to the effective prohibition of chemical weapons,

Have agreed as follows:

Article I
Basic Prohibition

Each Party undertakes not to:
(a) develop, produce, otherwise acquire, stockpile, or retain chemical weapons, or transfer chemical weapons to anyone;
(b) conduct other activities in preparation for use of chemical weapons;
(c) use chemical weapons in any armed conflict; or
(d) assist, encourage, or induce, directly or indirectly, anyone to engage in activities prohibited to Parties under this Convention.
CONVENTION ON THE PROHIBITION OF CHEMICAL WEAPONS

9. “Protective purposes” means purposes directly related to protection against chemical weapons, but does not mean purposes directly related to the development, production, other acquisition, stockpiling, retention or transfer of chemical weapons.

10. “Chemical weapons production facility” means any building or any equipment which in any degree was designed, constructed or used since January 1, 1946, for:
(a) the production for chemical weapons of any toxic chemical, except for those listed in Schedule B, or the production for chemical weapons of any key precursor; or
(b) the filling of chemical weapons.

11. “Other activities in preparation for use of chemical weapons” means (to be elaborated), but does not mean activities directly related to protective purposes.

Article III
Permitted Activities

1. Subject to the limitations contained in this Convention, each Party may retain, produce, acquire, transfer or use toxic chemicals, and their precursors, for permitted purposes, of types and in quantities consistent with such purposes.

2. The following measures shall apply to toxic chemicals for protective purposes:
(a) The retention, production, acquisition, and use of super-toxic lethal chemicals and key precursors for protective purposes shall be strictly limited to those amounts which can be justified for such purposes. At no time shall the aggregate amount possessed by a Party exceed one metric ton, nor shall the aggregate amount acquired by a Party in any calendar year through production, withdrawal from chemical weapons stocks, and transfer exceed one metric ton. Once a Party has reached the aggregate one metric ton permitted per year, it must not acquire any further such super-toxic lethal chemicals until the next year, at which time it may then acquire only those amounts of such chemicals to replace amounts used or transferred to another Party for protective purposes.
(b) Each Party which produces super-toxic lethal chemicals or key precursors for protective purposes shall carry out the production at a single specialized facility, the capacity of which shall not exceed (an agreed limit). Information on the facility and its operations shall be provided in accordance with Annex II. The facility shall be subject to systematic international on-site verification, through on-site inspection and continuous monitoring with on-site instruments in accordance with Annex II.
(c) Each Party shall, in accordance with Annex II, make an annual declaration regarding all key precursors devoted to protective purposes and all toxic chemicals that can be used as chemical weapons but are devoted to protective purposes, as well as provide other specified information on its protective activities.
(d) The provisions of the Convention do not preclude transfer for protective purposes of super-toxic lethal chemicals or key precursors produced or otherwise acquired for such purposes. Such transfers may be made.
only to another Party. The maximum quantity transferred to any Party shall not exceed (quantity) in any 12-month period, nor shall it cause the receiving Party to exceed the aggregate limit specified in subparagraph 2(a) of this Article. Prior to any transfer of such super-toxic lethal chemical or key precursor, the transferring Party shall provide the information specified in Annex II. Items transferred may not be retransferred to another State.

3. In view of the particular risk they pose to achieving the objectives of the Convention, the chemicals listed in Schedules A, B, and C shall be subject to the special measures specified in Annex III.
   (a) In respect of chemicals in Schedule A, each Party shall prohibit all production and use except for production and use of laboratory quantities for research, medical, or protective purposes at establishments approved by the Party; and
   (b) Facilities producing chemicals listed in Schedule C for permitted purposes shall be subject to systematic international on-site verification, through on-site inspection and monitoring with on-site instruments, as specified in Annex II.

4. A Party in a position to do so may assist another Party in destruction of chemical weapons, including shipment of chemical weapons to its territory for the purpose of destroying them, or in destruction of chemical weapons production facilities.

5. This Convention shall be implemented in a manner designed insofar as possible to avoid hampering the economic and technological activities of Parties to the Convention or international cooperation in the field of peaceful chemical activities including the international exchange of toxic chemicals and equipment for the production, processing, or use of toxic chemicals for peaceful purposes in accordance with the provisions of the Convention.

Article IV
Declaration of Chemical Weapons, Chemical Weapons Production Facilities and Past Transfers

1. Each Party shall file a declaration, within thirty days after the Convention enters into force for it, stating whether it has under its control anywhere, any chemical weapons, any chemical weapons production facility, any super-toxic lethal chemicals or key precursors for protective purposes, or any production facility for super-toxic lethal chemicals and key precursors for protective purposes. The declaration shall also state whether the Party has on its territory, under the control of others, including a State not party to this Convention, any of the foregoing and their locations.

2. The declaration filed by each Party shall comply with the requirements of Annex II and shall state:
   (a) the precise location of any chemical weapons under its control and the detailed inventory of the chemical weapons at each location;
   (b) its general plans for destruction of any chemical weapons under its control;

   (c) the precise location, nature, and capacity of any chemical weapons production facility under its control at any time since January 1, 1946;
   (d) its plans for closing and eventually destroying any chemical weapons production facilities under its control;
   (e) the precise location and capacity of the single specialized production facility, if any, for super-toxic lethal chemicals and key precursors permitted by subparagraph 2(b) of Article III;
   (f) the precise location and nature of any other facility under its control designed, constructed or used, since (date) for the production of chemicals listed in Schedules B and C;
   (g) the precise location and nature of any facility under its control designed, constructed, or used since (date), for development of chemical weapons, including test and evaluation sites; and
   (h) whether the Party has transferred control of chemical weapons or equipment for their production since (date) or has received such weapons or equipment since that date. If so, specific information shall be provided in accordance with Annex II.

Article V
Chemical Weapons

1. Each Party shall, in accordance with Annex II:
   (a) provide information on the location and composition of any chemical weapons, pursuant to Article IV;
   (b) provide a general plan for destroying its chemical weapons, pursuant to Article IV and, subsequently, provide more detailed plans;
   (c) ensure access to its chemical weapons immediately after the declaration is filed, for the purpose of systematic international on-site verification of the declaration, through on-site inspection;
   (d) ensure access to its chemical weapons for the purpose of systematic international on-site verification, through on-site inspection and continuous monitoring with on-site instruments, that the chemical weapons are not removed except to a destruction facility;
   (e) destroy its chemical weapons, pursuant to the timetable specified in Annex II, beginning not later than twelve months, and finishing not later than ten years, after the Convention enters into force for it;
   (f) provide access to the destruction process for the purpose of systematic international on-site verification of destruction, through the continuous presence of inspectors and continuous monitoring with on-site instruments;
   (g) provide information annually during the destruction process regarding implementation of its plan for destruction of chemical weapons; and
   (h) certify, not later than thirty days after the destruction process has been completed, that its chemical weapons have been destroyed.

2. All locations where chemical weapons are stored or destroyed shall be subject to systematic international on-site verification, through on-site inspection and monitoring with on-site instruments in accordance with Annex II.

3. Old chemical weapons found after the declarations required by Article IV and this Article have been filed shall be subject to the provisions of Annex
II regarding notification, interim storage, and destruction, as well as systematic international on-site verification of these actions. These provisions shall also apply to chemical weapons which were inadequately disposed of in the past and are subsequently retrieved. A detailed explanation shall be given as to why these chemical weapons were not declared in the declarations filed pursuant to Article IV and this Article.

4. Any Party which has on its territory chemical weapons which are under the control of a State which is not a Party to this Convention shall ensure that such weapons are removed from its territory not later than (____) months after the date on which the Convention entered into force for it.

Article VI
Chemical Weapons Production Facilities

1. Each Party shall, in accordance with Annex II,
   (a) cease immediately all activity at each of its chemical weapons production facilities, except that required for closure;
   (b) close each of its chemical weapons production facilities within three months after the Convention enters into force for it in a manner that will render those facilities inoperable;
   (c) provide information on the location, nature and capacity of any chemical weapons production facility, pursuant to Article IV;
   (d) provide a general plan for destroying its chemical weapons production facilities, pursuant to Article IV and, subsequently, provide more detailed plans;
   (e) provide access to each chemical weapons production facility immediately after the declaration is filed, for the purpose of systematic international on-site verification of the declaration through on-site inspection;
   (f) provide access to each chemical weapons production facility for the purpose of systematic international on-site verification that the facility remains closed and is eventually destroyed, through periodic on-site inspection and continuous monitoring by on-site instruments;
   (g) destroy its chemical weapons production facilities, pursuant to the timetable specified in Annex II, beginning not later than twelve months, and finishing not later than ten years, after the Convention enters into force for it;
   (h) provide information annually during the destruction period regarding the implementation of its plan for destruction of chemical weapons production facilities; and
   (i) certify, not later than thirty days after the destruction process has been completed, that its chemical weapons production facilities have been destroyed.

2. All chemical weapons production facilities shall be subject to systematic internal on-site verification, through on-site inspection and monitoring with on-site instruments in accordance with Annex II.

3. No Party shall construct any new chemical weapons production facilities, or modify any existing facilities, for purposes prohibited by the Convention.

4. A chemical weapons production facility may be temporarily converted for destruction of chemical weapons. Such a converted facility must be destroyed as soon as it is no longer in use for destruction of chemical weapons and, in any case, not later than the deadline for destruction of chemical weapons production facilities set forth in subparagraph 1(g) of this Article.

Article VII
Consultative Committee

1. A Consultative Committee shall be established upon entry into force of this Convention. Each Party shall be entitled to designate a representative to the Consultative Committee.

2. The Consultative Committee shall oversee the implementation of the Convention, promote the verification of compliance with the Convention, and carry out international consultations and co-operation among Parties to the Convention. For these purposes it shall:
   (a) carry out systematic international on-site verification, through on-site inspection and monitoring with on-site instruments, of:
      (i) chemical weapons,
      (ii) destruction of chemical weapons,
      (iii) closure and destruction of chemical weapons production facilities,
      (iv) permitted single specialized facilities for production of super-toxic lethal chemicals and key precursors for protective purposes, and
      (v) production for permitted purposes of the chemicals specified in Schedule C;
   (b) provide a forum for discussion of any questions raised relating to the objectives, or the implementation, of the Convention;
   (c) conduct special on-site inspections under Article X and ad hoc on-site inspections under Article XI;
   (d) participate in any inspections agreed among two or more Parties as referred to in paragraph 2 of Article IX, if requested to do so by one of the Parties involved;
   (e) develop, and revise as necessary, detailed procedures for exchange of information, for declarations and for technical matters related to the implementation of the Convention;
   (f) review scientific and technical developments which could affect the operation of the Convention;
   (g) meet in regular session annually; and
   (h) review the operation of the Convention at five-year intervals unless otherwise agreed by a majority of the Parties.

3. The Consultative Committee shall establish an Executive Council which shall have delegated authority to discharge the functions of the Committee set out in subparagraphs 2(a), 2(c), 2(d) and 2(e) of this Article, and any other functions which the Committee may from time to time delegate to it. The Council shall report to the Committee at its regular sessions on its exercise of these functions.

4. Each Party shall cooperate fully with the Consultative Committee in the exercise of its verification responsibilities.
5. Further functions and the organization of the Consultative Committee, the Executive Council, the Fact-Finding Panel, the Technical Secretariat and other subsidiary organs are specified in Annex I.

**Article VIII**
Non-Interference with Verification

A Party shall not interfere with the conduct of verification activities. This shall apply to verification activities conducted in accordance with the Convention by the designated representatives of the Consultative Committee or by Parties, and shall include verification activities conducted by national technical means in a manner consistent with generally recognized principles of international law.

**Article IX**
Consultation and Co-operation: Resolving Compliance Issues

1. Parties shall consult and co-operate, directly among themselves, or through the Consultative Committee or other appropriate international procedures, including procedures within the framework of the United Nations and in accordance with its Charter, on any matter which may be raised relating to the objectives or the implementation of the provisions of this Convention.

2. Parties shall make every possible effort to clarify and resolve, through bilateral consultation, any matter which may cause doubts about compliance with this Convention or which gives rise to concerns about a related matter which may be considered ambiguous. A Party which receives a request from another Party for clarification of any matter which the requesting Party believes causes such doubts or concerns shall provide the requesting Party, within seven days of the request, with information sufficient to answer the doubts or concerns raised along with an explanation of how the information provided resolves the matter. Nothing in this Convention affects the right of any two or more Parties from arranging by mutual consent for inspections among themselves to clarify and resolve any matter which may cause doubts about compliance or gives rise to concerns about a related matter which may be considered ambiguous. Such arrangements shall not affect the rights and obligations of any Party under other provisions of this Convention.

3. In order to facilitate satisfactory resolution of matters raised, the Parties concerned may request the assistance of the Consultative Committee or its subsidiary organs. Any Party may request the Executive Council to conduct fact-finding procedures with regard to the Party's own activities or the activities of another Party in order to clarify and resolve any matter which may cause doubts about compliance with the Convention or gives rise to concerns about a related matter which may be considered ambiguous.

(a) Requests sent to the Executive Council under this Article shall state the doubts or concerns, the specific reasons for the doubts or concerns, and the action that the Council is being requested to undertake.

(b) Within two days of receipt of such a request, the Technical Secretariat shall, on behalf of the Council, request the Party whose activities create the doubts or concerns to clarify the state of affairs.

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(c) If the doubts or concerns which gave rise to the request have not been resolved within ten days of the receipt of the request by the Council, its Fact-Finding Panel shall immediately initiate a fact-finding inquiry, and transmit to the Chairman of the Council a report on its work, whether interim or final, within two months of the date of the request. Reports of the Panel shall include all views and information presented during its proceedings.

(d) All requests for special on-site inspections shall be governed by Article X and all requests for ad hoc on-site inspections by Article XI.

4. Any Party whose doubts or concerns about compliance have not been resolved within two months or any Party which has doubts or concerns it believes warrant urgent consideration by all Parties regarding compliance or regarding other matters directly related to the objectives of the Convention may request the Chairman of the Consultative Committee to convene a special meeting of the Committee. The Chairman of the Committee shall convene such a meeting as soon as possible and in any case within one month of the receipt of the request. Each Party may participate in such a meeting, whose functions and rules of procedure are established in Annex I.

5. All Parties shall co-operate fully with the Consultative Committee and its subsidiary organs, as well as with international organizations, which may, as appropriate, give scientific, technical and administrative support in order to facilitate fact-finding activities and thereby help to ensure the speedy resolution of the matter which gave rise to the original request.

6. The Executive Council shall promptly notify all Parties of the initiation of any fact-finding procedures and shall provide all available information related thereto to any Party upon request. All Parties shall also be promptly notified of the refusal by a Party of any request made by the Committee or its subsidiary organs as part of a fact-finding inquiry. All reports regarding the fact-finding activities conducted under this Article, as well as on-site inspections under Articles X and XI shall be distributed promptly to all Parties.

7. The provisions of this Article shall not be interpreted as affecting the rights and duties of Parties under Articles X and XI or under the Charter of the United Nations.

**Article X**
Special On-Site Inspection

1. In accordance with the provisions of this Article and Annex II, each member of the Fact-Finding Panel shall have the right to request at any time a special on-site inspection of any other Party, through the Technical Secretariat, to clarify and resolve any matter which may cause doubts about compliance or gives rise to concerns about a related matter which may be considered ambiguous, of:

(a) any location or facility subject to systematic international on-site inspection pursuant to Articles III, V, and VI; or

(b) any military location or facility, any other location or facility owned by the Government of a Party, and as set forth in Annex II, locations or facilities controlled by the Government of a Party.
2. A request shall be handled in the following manner:
   (a) Within twenty-four hours of the request, the Technical Secretariat shall notify the Party to be inspected, and designate an inspection in accordance with paragraph 3 of this Article; and
   (b) Within twenty-four hours after the receipt of such notification, the Party to be inspected shall provide the inspection team unimpeded access to the location or facility.

3. Each Party may solicit from any member of the Fact-Finding Panel a request for an inspection of any other Party under this Article.

4. Any special on-site inspection requested through the Technical Secretariat shall be carried out by inspectors designated from among the full-time inspectors of the Secretariat. Each inspection team shall consist of one inspector from each member State of the Fact-Finding Panel, except that if the Party to be inspected is a member State of the Panel, the team shall not include any inspector from that State. The team shall promptly provide a written report to the requesting Party, the inspected Party, and the Fact-Finding Panel. Each inspector shall have the right to have his individual views included in the report.

Article XI
Ad Hoc On-Site Inspection

1. In accordance with the provisions of this Article and Annex II, each Party shall have the right to request, at any time, the Consultative Committee to conduct an ad hoc on-site inspection, to clarify and resolve any matter which may cause doubts about compliance or gives rise to concerns about a related matter which may be considered ambiguous, of any location or facility not subject to Article X.

2. A request shall be handled in the following manner:
   (a) The Fact-Finding Panel shall meet within twenty-four hours to determine whether to request such an ad hoc on-site inspection using the guidelines in Section II of Annex II.
   (b) If the Fact-Finding Panel decides to request an ad hoc inspection, the Party to be inspected shall, except for the most exceptional reasons, provide access within twenty-four hours of the Panel’s request.
   (c) If the Party to be inspected refuses such a request it shall provide a full explanation of the reasons for the refusal and a detailed, concrete proposal for an alternative means of resolving the concerns which gave rise to the request. The Fact-Finding Panel shall assess the explanation and alternative submitted, and may send another request, taking into account all relevant elements, including possible new elements received by the Panel after the original request.
   (d) If the request is again rejected, the Chairman shall immediately inform the Security Council of the United Nations.

Article XII
Domestic Implementation Measures

Each Party shall:
   (a) take any measures necessary in accordance with its constitutional processes to implement this Convention and, in particular, to prohibit and prevent any activity that a Party is prohibited from conducting by this Convention anywhere under its jurisdiction or control, and
   (b) inform the Consultative Committee of the measures it has taken to implement the Convention.

Article XIII
Assistance to Parties Endangered by Chemical Weapons

Each Party undertakes, to the extent it deems appropriate, to render assistance to any Party to this Convention that the Security Council of the United Nations decides has been exposed to danger as a result of a violation of the Convention.

Article XIV
Non-Interference with Other Agreements

1. Nothing in this Convention shall be interpreted as in any way limiting or detracting from the obligations assumed by any State under the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, or under the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxic Weapons and on Their Destruction, signed at Washington, London, and Moscow on 10 April 1972.

2. Each Party to this Convention that is also a Party to the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare, signed at Geneva on 17 June 1925, affirms that the obligation set forth in subparagraph (c) of Article I supplements its obligations under the Protocol.

Article XV
Amendments

Any Party may propose amendments to this Convention. Amendments shall enter into force for Parties ratifying or acceding to them on the thirtieth day following the deposit of instruments of ratification or accession by a majority of the Parties to the Convention and thereafter for each remaining Party on the thirtieth day following the deposit of its instrument of ratification or accession.
FPI POLICY BRIEFS

Article XVI
Duration; Withdrawal

1. This Convention shall be of unlimited duration.

2. Every Party to this Convention shall, in exercising its national sovereignty, have the right to withdraw from the Convention if it decides that extraordinary events, related to the subject matter of the Convention, have jeopardized the supreme interests of its country. It shall give notice of such withdrawal to all other Parties to the Convention, to the Depositary and to the Security Council of the United Nations three months in advance. Such notice shall include a statement of the extraordinary events it regards as having jeopardized its supreme interests.

Article XVII
Signature; Ratification; Entry into Force

1. This Convention shall be open to all States for signature.

2. Any State which does not sign the Convention before its entry into force in accordance with paragraph 6 of this Article may accede to it at any time.

3. This Convention and its Annexes, which form an integral part thereof, shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Secretary-General of the United Nations, hereby designated as the Depositary.

4. This Convention shall enter into force thirty days after the date of deposit of the (fortieth) instrument of ratification.

5. For each State ratifying or succeeding after the deposit of the (fortieth) instrument of ratification or accession, the Convention shall enter into force on the thirtieth day following the deposit of the instrument of ratification or accession.

6. The Depositary shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification or of accession and the date of of the entry into force of this Convention, and of the receipt of other notices. The Depositary shall immediately upon receipt transmit any notices required by this Convention to every Party.

7. This Convention shall be registered by the Depositary pursuant to Article 102 of the Charter of the United Nations.

Article XVIII
Languages
This Convention, the English, Arabic, Chinese, French, Russian, and Spanish texts of which are equally authentic, shall be deposited with the Secretary-General of the United Nations.

DETAILED UNITED STATES VIEWS ON THE CONTENTS OF THE ANNEXES TO THE CONVENTION*

Annex I
CONSULTATIVE COMMITTEE

Provisions should be included along the following lines:

Section A. General Provisions

1. The Consultative Committee established pursuant to Article VII should convene in (sense) not later than thirty days after the Convention enters into force.

2. The Consultative Committee should subsequently meet in regular sessions annually for the first ten years after the Convention enters into force, and annually thereafter unless a majority of Parties agrees that a meeting is unnecessary. A special meeting may be convened at the request of any Party or of the Executive Council.

3. In order to assist it in carrying out its functions, the Consultative Committee should establish an Executive Council, as provided in Section B of this Annex, as well as a Fact-Finding Panel, a Technical Secretariat and such other subsidiary bodies as may be necessary for its work.

4. The Executive Council should be responsible for carrying out the functions of the Consultative Committee specified in paragraph 2 of Article VII during the period when the latter is not in session. In particular, it shall be responsible for the activities in paragraph 1 of Section B of this Annex.

5. Except as specified elsewhere, the Committee and its subordinate bodies should take decisions where possible by consensus. If consensus cannot be reached within twenty-four hours, a decision may be taken by a majority of those present and voting. The report on a fact-finding inquiry should not be put to a vote, nor should any decision be taken as to whether a Party is complying with the provisions of the Convention.

6. The chairman of the Committee should be chosen by the Committee itself.

7. The Committee should present an annual report on its activities to the Parties.

8. The expenses of the Committee should be met by (_______).

9. The question of international legal personality of the Committee and its subsidiary organs should be addressed.

Section B. Executive Council

1. In carrying out its responsibilities, the Executive Council should, in particular, be responsible for:
   (a) carrying out systematic international on-site verification;
   (b) ensuring the implementation of, and compliance with, the Convention;

*This paper presents current U.S. views on the contents of the annexes of a chemical weapons convention. It is subject to further modification, elaboration and refinement.
(c) obtaining, keeping and disseminating information submitted by Parties regarding matters pertaining to the Convention;
(d) rendering services to Parties and facilitating consultations among them;
(e) receiving requests from Parties, including requests for fact-finding;
(f) deciding and overseeing specific action to be taken regarding such requests;
(g) overseeing the activities of the other subordinate bodies of the Consultative Committee, including ensuring the proper execution of the functions of the Technical Secretariat, including the carrying out of systematic international on-site verification pursuant to Articles III, V, VI; the carrying out of special on-site inspections pursuant to Article X; and the carrying out of ad hoc on-site inspections pursuant to Article XI;
(h) reporting to the Consultative Committee; and
(i) requesting, when it deems necessary, a special meeting of the Consultative Committee.

2. (a) The Executive Council should be established within forty-five days after the entry into force of the Convention and should be composed of one representative from each of not more than fifteen Parties, plus a non-voting chairman.
(b) Ten members should be elected by the Consultative Committee after nominations by the Chairman based on consultation with the Parties. In selecting these members, due regard should be given to ensuring an appropriate geographic balance. These members should serve for a two-year period, with five of these members replaced each year.
(c) In addition, those permanent members of the Security Council of the United Nations who are Parties to the Convention should be represented.
(d) Each member may be assisted at meetings by one or more technical or other advisers.
(e) The Chairman of the Consultative Committee should serve as Chairman of the Executive Council.

Section C. Fact-Finding Panel

1. Within forty-five days after the entry into force of the Convention, the Consultative Committee should establish a Fact-Finding Panel subordinate to the Executive Council, which should be responsible for conducting fact-finding inquiries pursuant to Article IX, considering reports on special on-site inspections pursuant to Article X, and overseeing ad hoc inspections pursuant to Article XI.

2. (a) The Fact-Finding Panel should consist of diplomatic representatives of five Parties, plus a non-voting chairman.
(b) Three Parties should be selected by the Consultative Committee by a four-fifths vote after nominations by the Chairman based on consultations with Parties. These member states should serve for a six-year period, with one Party being replaced every other year. Of these three Parties, one should represent the Western group, one the Eastern group, and one the (neutral/non-aligned) group.
Section E. Special Meeting of the Consultative Committee

1. The special meeting of the Consultative Committee provided for in Article IX should undertake to solve any problem which may be raised by the Party requesting the meeting. For this purpose, the assembled Parties should be entitled to request and receive any information which a Party is in a position to communicate.

2. The work of the special meeting should be organized in such a way as to permit it to perform its functions.

3. Any Party should be able to participate in the meeting. The meeting should be chaired by the Chairman of the Committee.

4. Each Party should have the right, through the Chairman, to request from States and from international organizations such information and assistance as the Party considers desirable for the accomplishment of the work of the meeting.

5. A summary of the meeting, incorporating all views and information presented during the meeting, should be prepared promptly and distributed to all Parties.

Annex II
VERIFICATION

Provisions along the following lines should be included:

Section A. Declarations

A. General Provisions

1. Unless otherwise stipulated, information required to be provided should be submitted to the Depositary until the Consultative Committee is established and thereafter to the Committee. The information should be provided according to a standard format, which should be specified by the Depositary, after consultation with signatories, for information submitted before establishment of the Committee, or specified by the Committee for information submitted after its establishment. The information should be made available to Parties.

2. Locations should be specified with sufficient precision to permit unambiguous identification of sites and facilities. For this reason all locations should be specified by geographical place name and co-ordinates, as well as by any other official or commonly used designation, and should be clearly marked on maps of a suitable scale. For facilities within complexes, the exact position within the complex should be specified.

3. The accuracy and completeness of all declarations should be subject to the procedures specified in Articles IX, X and XI. As specified in subsections B and C, declarations should also be subject to systematic international on-site verification.

B. Contents of the declarations required by Articles IV, V and VI

1. Chemicals should be declared by scientific chemical name, chemical structural formula, toxicity and weight. The fraction in munitions and devices should be given. Munitions and devices should be declared by type and quantity. "Specifically-designed" equipment and chemicals, referred to in Article II, subparagraph 3(c), should be declared by type and quantity.

2. The exact location of chemical weapons within a site and form of storage (bulk, cylinder, etc.) should be declared, and storage standards should be provided.

3. The general plan for destruction of chemical weapons should include the type of operation, schedules of quantities and types of chemical weapons to be destroyed, and products.

4. Chemical weapons production facilities should be declared even if they have been destroyed; are now being used for other purposes; or were or are dual-purpose facilities designed or used in any degree for civilian production. The declaration should specify the chemical name of any chemicals, including civilian products, if any, ever produced at the facility, whether the facility still exists; and, if not, its disposition.

5. The information regarding existing chemical weapons production facilities should include information about the chemical process used, precisely what
equipment and structures are at the facility, including any old or replacement equipment not in use, as well as equipment and spare parts stored at the facility; the methods that will be used to close and eventually to destroy the equipment and structures; the general methods that will be used to dispose of the debris left from the destruction process; and the time periods (i.e., the months or years) when specific production facilities will be destroyed, respectively.

6. The declaration regarding a single specialized production facility for super-toxic lethal chemicals and key precursors for protective purposes should include a detailed description of the equipment at the facility.

7. The capacity of a chemical weapons production facility, or of a single specialized facility for production of super-toxic lethal chemicals or key precursors for protective purposes, should be expressed in terms of the quantity of end product that can be produced in (period), assuming that the facility operates (schedule). The capacity of a chemical weapons production facility used for filling chemical weapons should be expressed as the quantity of chemical that can be filled into munitions or other chemical weapons in (period), assuming that the facility operates (schedule).

8. With respect to past transfers, Parties should be required to make a declaration covering activities since (date). The declaration should specify the supplier and recipient countries, timing and nature of the transfer and the current location of the transferred items, if known. The following should be declared:

(a) transfers of any weapon significantly significant quantities (e.g., one ton) of toxic chemicals, munitions, devices or equipment for chemical weapons purposes; and

(b) transfers of equipment specifically designed or constructed for production of chemicals, munitions, devices or equipment for chemical weapons purposes.

C. Contents of Other Declarations

1. A declaration should be made annually regarding activities for protective purposes. It should cover activities actually conducted in the past year and those planned for the coming year. Information should be provided on:

(a) operations of any single specialized facility for production of super-toxic lethal chemicals and key precursors, including the schedule and names and quantities of chemicals involved;

(b) the scientific chemical name, chemical structural formula, quantity and use of each key precursor devoted to protective purposes and each toxic chemical that can be used as a chemical weapon but is devoted to protective purposes;

(c) (other protective activities to be agreed).

2. As specified in Article III and Annex III, a declaration should be made annually regarding the chemicals listed in Schedules A, B, and C.

3. Thirty days prior to the transfer to another Party of any super-toxic lethal chemical or key precursor for protective purposes, information should be provided on the recipient, and on the scientific chemical name, chemical structural formula, quantity, and end use, of the chemical transferred.

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4. The detailed plan for destruction of chemical weapons, to be provided pursuant to Article V, should be submitted six months before destruction operations are to begin and should contain agreed information necessary for the planning and carrying out of systematic international on-site verification.

5. The detailed plan for destruction of any chemical weapons production facility, to be provided pursuant to Article VI, should be submitted six months before destruction operations are to begin and should contain agreed information necessary for the planning and carrying out of systematic international on-site verification.

6. As specified in Articles V and VI, notifications should be provided annually regarding the implementation of plans for destruction of chemical weapons and chemical weapons production facilities, respectively. These notifications should contain agreed information on activities actually conducted in the past year and those planned for the coming year. Information should also be provided on any changes in the detailed plans for destruction.

7. Should any Party discover or retrieve any old chemical weapons (e.g., weapons found on World War I battlefields or dumped at sea after World War II) anywhere under its jurisdiction or control after the declarations required by Articles IV and V have been filed, it should:

(a) notify the Consultative Committee promptly of the approximate quantity and type of the chemical weapons found. The notification shall also specify how, where, and when the chemical weapons were found, why they were previously undeclared, and where they are located. The notification should be filed within 45 days of the discovery. In the case of multiple and frequent discoveries of small quantities, a notification may cover a one-month period; such a notification should be made within 20 days of the end of the reporting month; and

(b) notify the Consultative Committee, within five months of the first notification, regarding the exact quantity and type of chemical weapon found, including the scientific chemical name and chemical structural formula of any toxic chemical found and its quantity. The notification should specify plans for the destruction of the chemical weapons.

(c) In the event that some of the information stipulated under subparagraphs (a) and (b) of this paragraph cannot be provided within the periods specified, submit as much information as possible, specify the reasons the remainder is unavailable, and give an estimate of when such information might be provided.

Section B. On-Site Verification

A. General Provisions

1. All on-site verification, whether systematic international verification, special on-site inspection or ad hoc on-site inspection, under the auspices of the Consultative Committee should be carried out according to procedures which are agreed in advance and based on this Annex.

2. On-site verification should make use of both on-site inspectors and on-site instruments.
3. The Executive Council and the host Party should promptly agree upon subsidiary arrangements which specify in detail, to the extent necessary to permit the Committee to fulfill its verification responsibilities in an effective and efficient manner, how the on-site verification provisions will be implemented at each of the locations subject to systematic international on-site verification.

4. The privileges and immunities which should be granted to inspectors to ensure that they can discharge their functions effectively should be specified. The steps that a Party should take to ensure that inspectors can effectively discharge their functions in its territory should also be specified.

5. Certain rights of a Party with respect to the conduct of verification in its territory should be specified. For example, although it should not be required, host Party representatives should be allowed to accompany international inspectors during on-site inspections.

6. Pursuant to the obligation in Article VIII not to interfere in any manner with the conduct of verification activities:
   (a) entry visas for inspectors should be issued promptly;
   (b) host Party representatives should be ready to accompany the inspectors immediately. No delays in carrying out the inspections should be allowed to occur under the guise of the unavailability of appropriate host Party representation;
   (c) no bureaucratic constraints (e.g., governmental travel approval) should be imposed which would interfere with the inspection or provide the host Party with sufficient advance notification of the site to be inspected that the host Party could cover up possible prohibited activities prior to the inspection.

7. The Consultative Committee and the Party concerned should be required to co-operate to facilitate the implementation of the verification measures specified by the Convention.

8. Verification measures should be implemented in a manner designed:
   (a) to avoid hampering the economic and technological activities of Parties; and
   (b) to be consistent with management practices required for the safe conduct of the activities subject to verification.

9. On-site instruments should incorporate a capability for remote monitoring. They should also incorporate data protection and tamper-detecting devices and be serviced only by international inspectors.

10. Full account should be taken of technological developments in order to ensure optimum effectiveness of verification.

11. An agreed timetable for destruction activities should be included to facilitate verification and to ensure that no Party gains military advantage during the destruction period.

B. Inspection and Interim Monitoring of Stocks

1. After a Party has filed its declarations pursuant to Articles IV and V, chemical weapons should be subject to inspection immediately, under agreed procedures, to confirm the accuracy of the declarations. These inspections should be completed within (number) days after the filing of the declarations.

2. To ensure that a Party does not move chemical weapons to a deployment site or to a clandestine site prior to destruction, the storage facilities should be equipped with monitoring instruments by international inspectors immediately following the confirmatory inspection.

3. During confirmatory inspection of chemical weapons, an on-site survey of each location should be made to determine what pre-agreed types of instruments would be placed to monitor the chemical weapons there prior to removal and destruction. The instruments should be installed and tested by the inspecting team, in the presence of host Party personnel, before the site and facility are declared secure. After placement of instruments is complete, on-site inspection should be repeated to confirm that no chemical weapons had been removed from that location since the initial confirmatory inspection. An additional set of agreed procedures should be developed for the removal of chemical weapons from each storage site for transfer to a destruction facility. Until all chemical weapons have been removed for destruction, the storage site should be visited periodically by an international inspection team for routine monitoring and maintenance purposes, e.g., testing the system of instruments.

C. Verification of the Destruction of Chemical Weapons

1. The verification procedures should be designed to confirm that chemical weapons are not diverted during transport or any phase of the destruction process and to confirm that the type and quantity of materials destroyed correspond to the declarations and that all materials are actually destroyed.

2. Transport of chemical weapons from storage sites and their destruction should be verified by systematic, international on-site procedures. International inspectors should be present at the storage facility when chemical weapons are removed for shipment to declared destruction facilities. The inspectors should verify the chemical weapons being moved and resecure the storage facility once they have been loaded on transports. (However, inspectors would not need to accompany the shipments.) Inspectors should verify that the chemical weapons are received at the destruction facility and placed in interim storage there. On-site instruments, as well as inspectors, should be utilized for verification of destruction. Inspectors should be present in the destruction facility continuously when the facility is operating.

3. The destruction procedures should permit systematic international on-site verification. The following procedures should not be used for the destruction of chemical weapons: dumping in any body of water, land burial, or open-air burning. The destruction process should, for practical purposes, be irreversible.
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2. The precise location of the facility should be declared and the facility should be inspected by international inspectors before it is used to ensure that its capacity will not permit the production, on an annual basis, of quantities significantly in excess of one ton. On-site instruments should be installed which will signal whether the facility is active or inactive. An annual declaration should be made about planned production activities. International inspectors should have the right to visit the facility periodically to enable them to monitor production activities, as well as inactive periods, through on-site inspection.

G. Verification Measures Applicable to Production for Permitted Purposes of Chemicals Listed in Schedule C

1. The verification procedures should be designed to confirm that these facilities are not used to produce chemical weapons.

2. Inspections should occur periodically on a random basis. Such inspections should be conducted under agreed procedures which provide protection for proprietary information.

3. During an inspection, international inspectors should have the right to review certain agreed plant records and interview persons under agreed procedures. Inspectors should be allowed to view agreed areas; take samples from agreed points, such as finished product storage containers and waste treatment areas; and analyze them using agreed methods. Inspectors would not have the right to interfere with plant operations more than necessary to carry out their agreed functions.

4. Use of special instruments (e.g., end product samplers) between inspections should be permitted when deemed necessary by the inspectors.

5. Plans to change the end product of the facility or substantially change its capacity should be reported in advance to international authorities. Details of process modification need not be disclosed; however, final products and estimated time for completing the work should be provided. International inspectors should be permitted to view agreed areas soon after completion of the modifications. At that time, new or altered instruments should be installed, as required.

H. On-site Inspections under Articles X and XI

1. Agreed procedures for conducting on-site inspections under Articles X and XI should be specified in this Annex, including:
   (a) a requirement for definition of the area to be inspected;
   (b) time limits for providing access to the area to be inspected;
   (c) the maximum number of personnel on an inspection team;
   (d) length of service requirements for designation of inspectors;
   (e) routes of access and means of transportation;
   (f) types of experimental and support equipment which may be employed and who shall furnish specific types of equipment;
   (g) procedures for making observations and measurements, including collecting samples and taking photographs;

D. Closure, Inspection, and Interim Monitoring of Chemical Weapons Production Facilities

1. After a Party has filed its declarations pursuant to Articles IV and VI, chemical weapons production facilities should be immediately subject to inspection to confirm the accuracy of the declaration, and to confirm the implementation of agreed procedures for closure. These inspections should be completed within (number) days after the filing of the declaration. Subsequent verification procedures should be implemented to confirm that Parties have not resumed production or filling at the facility and to confirm that equipment has not been removed.

2. An inventory of key equipment should be prepared, and its accuracy verified by international inspectors during confirmatory inspection. At the same time, the inspector should survey the facility to determine which of the previously agreed types of instruments should be emplaced to monitor the facility until it is destroyed. The instruments should be installed and tested by the inspecting team, in the presence of host Party personnel, before the facility is declared secure. During the interim between securing the facility and actually destroying it, the facility should be visited periodically by an international inspection team for routine monitoring and maintenance purposes, e.g., testing the system of instruments.

E. Verification of the Destruction of Chemical Weapons Production Facilities

1. The verification procedures should be designed to confirm that chemical weapons production facilities have been destroyed.

2. International inspectors should be present at the facility to be destroyed prior to beginning destruction to verify that the inventory of structures, equipment, parts, etc., at the facility is consistent with the inventory prepared when the facility was secured. During destruction, inspectors need not be present continuously, provided agreed procedures, including the use of on-site instruments, are implemented to ensure that the facility remains inoperable during the destruction phases. On-site inspections would be conducted periodically throughout the destruction process.

3. Equipment specifically designed for chemical weapons production should be destroyed. All items to be destroyed should be destroyed according to agreed procedures which permit systematic international on-site verification. No equipment may be removed from the site prior to check-off from the original inventory by the inspectors. Structures should be destroyed completely, by razing, and a final international inspection performed.

F. Inspection and Monitoring of the Permitted Single Specialized Production Facility

1. The verification procedures should be designed to confirm that the production of super-toxic lethal chemicals and key precursors in quantities significantly in excess of one ton does not occur at the single specialized production facility.
(h) protection of proprietary and confidential information including liability for unauthorized disclosure of such information;
(i) services to be furnished by the host Party;
(j) rights of inspection personnel, including privileges and immunities;
(k) certain rights of the host Party;
(l) allocation of expenses;
(m) preparation of reports;
(n) dissemination of findings;
(o) additional rights to be exercised in specific situations; and
(p) duration of an inspection.

2. With regard to "locations or facilities controlled by the Government of a Party," referred to in Article X, subparagraph 1(b), this Annex should provide the means of specifying those categories of locations or facilities which shall be subject to special on-site inspections, including the relevant facilities used for the provision of goods and services to the Government of a Party. It is intended that this provision reach any location or facility that in the future might be suspected of being used for activities in violation of this Convention. The specification of such locations and facilities should be a reasonable one.

3. The Committee should use the following guidelines in determining whether to request a Party to permit an ad hoc inspection pursuant to Article XI:
(a) whether the information available to it causes any doubts about compliance with the convention or gives rise to any concerns about a related matter which may be considered ambiguous;
(b) whether the proposed inspection would assist in determining the facts;
(c) whether the locations to be inspected are clearly defined and limited to places relevant to determination of the facts; and
(d) whether the proposed arrangements will limit intrusion to the level necessary to determine the facts.

4. The Technical Secretariat should ensure that sufficient inspectors will always be readily available to carry out special on-site inspections pursuant to Article X and ad hoc on-site inspections pursuant to Article XI.

Annex III
SCHEDULES: CHEMICALS SUBJECT TO SPECIAL MEASURES; METHODS FOR MEASURING TOXICITY

Provisions along the following lines should be included:

1. Schedule A should contain super-toxic lethal chemicals, key precursors, and other particularly dangerous chemicals, which have been stockpiled as chemical weapons or which pose particular risk of such stockpiling. Information on the persons authorized to possess such chemicals, the quantity produced and used at each location and the end uses should be reported annually.

2. Schedule B should contain chemicals which are produced in large quantities for permitted purposes but which pose a particular risk of diversion to chemical weapons purposes. In respect of each chemical in Schedule B, every Party should report annually the location of each production facility and statistical data on the aggregate quantities produced, imported, and exported, and on the end uses of the chemical.

3. Schedule C should contain chemicals whose production for permitted purposes should be subject to systematic international on-site verification, including key precursors. In respect of each chemical listed in Schedule C, every Party should report annually, for each chemical which is produced, imported or exported in an aggregate amount greater than (quantity), the location of each production facility and statistical data on the aggregate quantities produced, imported, and exported, and on the end uses of the chemical. Plans to establish a new production facility or to change substantially the capacity of an existing production facility should be reported ninety days in advance. Production facilities should be subject to systematic international on-site inspection, pursuant to Article III.

4. Schedule D should contain agreed methods for measuring lethal toxicity.

5. If a Party has information which in its opinion may require a revision of Schedules A, B, C, or D, it should provide the information to the Chairman of the Consultative Committee who should transmit the information to all Parties. The Technical Secretariat should also submit any such information to the Committee.

6. The Executive Council should promptly examine, in the light of all information available to it, whether the Schedule in question should be revised. The Council may recommend that the Schedule be revised or it may recommend that no revision be made. Any recommendation should be communicated promptly to all Parties.

7. Any recommendation by the Executive Council should be reviewed by the Consultative Committee at its next regularly scheduled meeting. The Committee may decide to accept the recommendation as stated, or in revised form, or it may decide to reject the recommendation. If requested by five or more Parties, a special meeting of the Committee should be held to review the recommendation. A two-thirds vote of the Committee should be required to revise a Schedule.
SCHEDULE A

1. Ethyl S-2-diisopropylaminoethyl methylphosphonothiolate (VX)
2. Ethyl N,N-dimethylphosphoramidocyanidate (Tabun)
3. iso-Propyl methylphosphonofluoridate (Sarin)
4. 1,2,2-Trichloroethyl methylphosphonofluoridate (Soman)
5. Bis(2-chloroethyl) sulfide (Mustard gas)
6. 8-Quinclidinyl benzilate (BZ)
7. Saxitoxin
8. 3,5-Dimethylbutanol-2 (Pinacolyl alcohol)
9. Methylphosphonyldifluoride

SCHEDULE B

1. Carbonyl chloride (phosgene)
2. Cyanogen chloride
3. Hydrogen cyanide
4. Phosphorus oxychloride
5. Phosphorus trichloride
6. Trichloronitromethane (chloropicrin)
7. Thioglycol

SCHEDULE C

Key precursors for super-toxic lethal chemicals
1. Chemicals containing the P-methyl, P-ethyl or P-propyl bond
2. Methyl and/or ethyl esters of phosphorous acid
3. 3,5-dimethylbutanol-2 (pinacolyl alcohol)
4. N,N disubstituted B-amino ethanols
5. N,N disubstituted B-amino ethane thiol
6. N,N disubstituted B-aminoethyl halides
   (halide = Cl, Br or I)

Key precursors for other toxic chemicals
1. Phenyl, alkyl- or cycloalkyl-substituted glycolic acids
2. 3- or 4-hydroxypiperidines and their derivatives

Toxic chemicals
(to be discussed)

SCHEDULE D

Lethal toxicity should be measured by the procedures specified below:

(text of procedures contained in Document CD/CW/WP.30, Annexes III and IV; 22 March 1982)

Annex III

RECOMMENDED STANDARDIZED OPERATING PROCEDURES FOR ACUTE SUBCUTANEOUS TOXICITY DETERMINATIONS

1. Introduction

Three categories of agents were defined on the basis of their toxicity:
(i) super-toxic lethal chemicals;
(ii) other lethal chemicals;
(iii) other harmful chemicals.

Lethality limits in terms of LD₅₀ for subcutaneous administration were established to separate three toxic categories at 0.5 mg/kg and 10 mg/kg.

2. Principles of the test method

The test substance is administered to a group of animals in doses corresponding exactly to the category limits (0.5 or 10 mg/kg respectively). If in an actual test the death rate was greater than 50 percent, then the material would fall into the higher toxicity category; if it was less than 50 percent the material would fall into the lower toxicity category.

3. Description of the test procedure

3.1 Experimental animal. Healthy young adult male albino rats of Wistar strain weighing 200 ± 20 g should be used. The animals should be acclimatized to the laboratory conditions for at least five days prior to the test. The temperature of the animal room before and during the test should be 22 ± 3°C and the relative humidity should be 50–70 percent. With artificial lighting, the sequence should be 12 hours light, 12 hours dark. Conventional laboratory diets may be used for feeding with an unlimited supply of drinking water. The animals should be group-caged but the number of animals per cage should not interfere with proper observation of each animal. Prior to the test, the animals are randomized and divided into two groups; twenty animals in each group.

3.2 Test substance. Each test substance should be appropriately identified (chemical composition, origin, batch number, purity, solubility, stability, etc.) and stored under conditions ensuring its stability. Stability of the substance under the test conditions should also be known. A solution of the test substance should be prepared just before the test. Solutions with concentrations of 0.5 mg/ml and 10 mg/ml should be prepared. The preferable solvent is 0.95 percent saline. Where the solubility of the test substance is a problem, a minimum amount of an organic solvent such as ethanol, propylene glycol or polyethylene glycol may be used to achieve solution.

3.3 Test method. Twenty animals receive in the back region 1 ml/kg of the solution containing 0.5 mg/ml of the test substance. The number of dead animals is determined within 48 hours and again after seven days. If the death rate is lower than ten animals, another group of twenty animals should be injected by the same way with 1 ml/kg of the solution containing 10 mg/ml of the test substance. The number of dead animals should be determined within 48 hours and again after seven days. If the result is doubtful (e.g., death rate = 10), the test should be repeated.
3.4 Evaluation of the results. If the death rate in the first group of animals (receiving a solution containing 0.5 mg/ml) is equal to or higher than 50 per cent, the test substance will fall into the "super-toxic lethal chemical" category. If the death rate in the second group (receiving a solution containing 10 mg/ml) is equal to or higher than 50 percent, the test substance will fall into the "other lethal chemical" category; if lower than 50 percent, the test substance will fall into the "other harmful chemical."

4. Data reporting

A test report should include the following information:

(i) test conditions: date and hour of the test, air temperature and humidity;
(ii) animal data: strain, weight and origin of the animals;
(iii) test substance characterization: chemical composition, origin, batch number and purity (or impurities) of the substance; date of receipt, quantities received and used in the test; conditions of storage, solvent used in the test;
(iv) results: the number of dead animals in each group; evaluation of results.

Annex IV

RECOMMENDED STANDARDIZED OPERATING PROCEDURES FOR ACUTE INHALATION TOXICITY CRITERIA

1. In the assessment and evaluation of the toxic characteristics of chemicals a vapour state determination of acute inhalation toxicity is necessary. In every case, when it is possible, this test should be preceded by subcutaneous toxicity determination. Data from these studies constitute the initial steps in the establishing of a dosage regimen in subchronic and other studies and may provide additional information on the mode of toxic action of a substance. Three categories of agents were defined on the basis of their toxicity:

(i) super-toxic lethal chemicals;
(ii) other lethal chemicals;
(iii) other harmful chemicals.

Lethality limits in terms of LC₅₀ₐ for inhalatory application were established to separate three toxic categories at 2,000 mg min/m³ and 20,000 mg min/m³.

2. Principles of the test method

A group of animals is exposed for a defined period to the test substance concentration corresponding exactly to the category limits (2,000 mg min/m³ or 20,000 mg min/m³ respectively). If an actual test the death rate was greater than 50 percent, then the material would fall into the higher toxicity category; if it was lower than 50 percent, the material would fall into the lower toxicity category.

3. Description of the test procedure

3.1 Experimental animals. Healthy young adult male albino rats of Wistar strain weighing 200 ± 20 g should be used. The animals should be acclimatized to the laboratory conditions for at least five days prior to the test. The temperature of the animal room before and during the test should be 22 ± 3°C and the relative humidity should be 50-70 percent. With artificial lighting, the sequence should be 12 hours light, 12 hours dark. Conventional laboratory diets may be used in feeding with an unlimited supply of drinking water. The animals should be group-caged but the number of animals per cage should not interfere with proper observation of each animal. Prior to the test the animals are randomized and divided into two groups, twenty animals in each group.

3.2 Test substance. Each test substance should be appropriately identified (chemical composition, origin, batch number, purity, solubility, stability, boiling point, flash point, vapour pressure, etc.) and stored under conditions ensuring its stability. The stability of the substance under the test conditions should also be known.

3.3 Equipment. A constant vapour concentration may be produced by one of several methods:

(i) by means of an automatic syringe which drops the material onto a suitable heating system (e.g., hot plate),
(ii) by sending airstream through a solution containing the material (e.g., bubbling chamber),
(iii) by diffusion of the agent through a suitable material (e.g., diffusion chamber).
A dynamic inhalation system with a suitable analytical concentration control system should be used. The rate of air flow should be adjusted to ensure that conditions throughout the equipment are essentially the same. Both a whole body individual chamber exposure or head only exposure may be used.

3.4 Physical measurements. Measurements or monitoring should be conducted of the following parameters:
(i) the rate of air flow (preferably continuously),
(ii) the actual concentration of the test substance during the exposed period,
(iii) temperature and humidity.

3.5 Test method. Twenty animals are exposed for 10 minutes to the concentration of 200 mg/m³ and then removed from the chamber. The number of dead animals is determined within 48 hours and again after 7 days. If the death rate is lower than 10 animals, another group of twenty animals should be exposed for 10 minutes to the concentration of 2,000 mg/m³. The number of dead animals should be determined within 48 hours and again after 7 days. If the result is doubtful (e.g., death rate = 10), the test should be repeated.

3.6 Evaluation of results. If the death rate in the first group of animals (exposed to the concentration of 200 mg/m³) is equal to or higher than 50 percent, the test substance will fall into the "super-toxic lethal chemical" category. If the death rate in the second group (exposed to the concentration of 2,000 mg/m³) is equal to or higher than 50 percent, the test substance will fall into the "other lethal chemical" category; if it is lower than 50 percent, the test substance will fall into the "other harmful chemical."

4. Data reporting

A test report should include the following information:
(i) Test conditions: date and hour of the test, description of exposure chamber (type, dimensions, source of air, system for generating the test substance, method of conditioning air, treatment of exhaust air, etc.) and equipment for measuring temperature, humidity, air flow and concentration of the test substance.
(ii) Exposure data: air flow rate, temperature and humidity of air, nominal concentration (total amount of test substance fed into the equipment divided by volume of air), actual concentration in test breathing zone.
(iii) Animal data: strain, weight and origin of animals.
(iv) Test substance characterization: chemical composition, origin, batch number and purity (or impurities) of the substance; boiling point, flash point, vapour pressure; date of receipt, quantities received and used in the test; condition of storage, solvent used in the test.
(v) Results: number of dead animals in each group, evaluation of results.

5. The Conventi on on the Prohibition of Chemical Weapons

2. Not less than 90 days after the Convention is opened for signature a Preparatory Commission, composed of representatives of all signatory States, should be convened for the purpose of carrying out necessary preparations for the coming into force of the Convention’s provisions, including preparing the first session of the Consultative Committee.

3. The Commission should include one representative from each signatory. All decisions should be made by consensus. The Preparatory Commission should remain in existence until the Convention comes into force and thereafter until the first meeting of the Consultative Committee. Its actions must be consistent with the provisions of the Convention.

4. The expenses of the Preparatory Commission should be met as follows (details).

5. The Preparatory Commission should:
(a) elect its own officers, adopt its own rules of procedure, meet as often as necessary, determine its own place of meeting and establish such committees as it deems necessary;
(b) appoint an executive secretary and staff, who shall exercise powers and perform such duties as the Commission determines;
(c) make arrangements for the first session of the Consultative Committee, including preparing a provisional agenda, drafting rules of procedure, and choosing the site;
(d) make studies, reports, and recommendations for the consideration of the Consultative Committee at its first meeting on procedural matters of concern to the Committee which would require immediate attention, including:
   (1) financing of the activities for which the Committee is responsible;
   (2) the programs and budget for the first year of the Committee’s activities;
   (3) staffing of the Secretariat;
   (4) the location of the permanent offices of the Committee.

6. The Preparatory Commission should submit a comprehensive report on its activities to the Consultative Committee at the Committee’s first session.
GLOSSARY

**Adsorption.** The surface retention of solid, liquid, or gas molecules; adsorption contrasts with absorption, the penetration of these substances into the bulk of a solid or liquid.

**Challenge Inspection.** The inspection of production or storage facilities with the purpose of ascertaining the existence of chemical agents or precursor materials.

**Chemical Agent.** In chemical warfare terminology, any solid, liquid, or gas that through its chemical properties produces lethal, injurious, or irritant effects on humans.

**Data Link.** The physical equipment for automatic transmission and reception of information.

**Decomposition Product.** The substance produced by the structural breakdown of a molecule into smaller molecules or atoms.

**Flow and Process Control.** The use of a system of sensors to (1) measure the flow, pressure, and temperature of gases, liquids, or solid particles through or along conduits or channels, and (2) compile, interpret, and otherwise act on this information.

**Gas Chromatography.** A method by which complex mixtures can be separated and analyzed for the purpose of identification.

**Generic Detection.** In the detection of chemical weapons, the process of determining the existence of certain chemicals that, though different, have structural similarities that cause specific effects on the human body.

**Immunoassay.** The process of determining the relative toxicity and the identity of small quantities (picogram levels) of an unknown substance.

**Isotope.** One of two or more atoms having the same atomic number but different mass number.
OPTRODE. A fiber optic device that can determine some physical properties of a substance in an instrumentation analysis such as flow and process control.

PICTOGRAHAM. One trillionth of a gram.

PIEROLELECTRIC CRYSTALS. Asymmetrical crystals that have the property of forming electrical charges on their surfaces when mechanically stressed; conversely, the surfaces exhibit mechanical strains when electrically charged.

PORTABILITY. The ease with which an item or instrument can be carried or transported.

PRECURSOR CHEMICAL. In chemical weapons technology, a chemical that can be used in the production of a chemical with super-toxic, lethal, or harmful properties.

PURIFY. To remove unwanted constituents from a substance.

REAGENT. A chemical or chemical solution used to cause a chemical reaction for analytical purposes or to create a new substance.

REAL-TIME WARNING. A warning that is essentially simultaneous to the event being monitored.

REFRACTIVE INDEX. The numerical quantity denoting the magnitude of the change of direction of an electromagnetic or sound wave.

RUGGEDNESS. Durability.

SPECTROSCOPY. A technique for identifying chemical compounds by measuring the emission or absorption of light by a molecule.

SUPER-TOXIC. The characteristic of being particularly harmful to the human body as a result of physical contact, ingestion, or inhalation. As defined by the draft convention, "any toxic chemical with a median lethal dose which is less than or equal to (0.5) mg/kg (subcutaneous administration) or (2,000) mg/min/m² (by inhalation), when measured by the standard methods specified in Schedule D."

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