Verification Technologies and Industry

6

The PrepCom now meeting in The Hague will determine the types and parameters of monitoring equipment that will be permitted for CWC verification. Ideally, such equipment should permit effective detection of violations while minimizing unnecessary intrusiveness and avoiding the collection of proprietary information. Some verification experts have proposed establishing a series of 'decision points' in the inspection routine so that a plant visit could be terminated early if visual inspection or nonintrusive sampling techniques demonstrate that a plant is not producing chemical weapons. If suspicions persist, then more intrusive inspection measures—such as sophisticated chemical analysis or auditing of plant records-could be applied in a graduated manner.[1] For example, chemical sampling and analysis might begin with 'classification testing, ' or screening samples for the presence of the basic molecular components of CW agents (e.g., a phosphorus-alkyl bond or the presence of fluorine). If no such signatures are found, the inspection could be terminated.ated. If classification testing gives positive results, however, more intrusive analytical methods would be warranted.[2]

Since auditing of plant records during an inspection risks compromising proprietary data, companies will generally try to demonstrate their treaty compliance through visual inspection and chemical sampling, providing access to production records only if needed to resolve compliance concerns that cannot be

PACIFIC NORTHWEST LABORATORIES

[1] Kenneth E. Apt, Robert K. Sander, and Lawrence E. Wangen, ''Chemical Analysis for Verification of a CW Treaty, ' *Verification Technologies,* March/April 1991, pp. 7-12.

[2] Classification testing for elements such as phosphorus, sulfur, or fluorine has certain limitations because some known agents do not contain these elements (e.g., lewisite, nitrogen mustards, and BZ). Furthermore, detection would be complicated by significant environmental contamination from pesticides and herbicides containing sulfur and phosphorus. Thus, in many cases, classification tests will need to be more specific than simply identifying elements, particularly if non-classical agents are suspected.

addressed by other means. A graduated approach to verification would help satisfy industry's desire to protect proprietary data, while facilitating the OPCW's task of inspecting a large number of sites with limited financial and technical resources.[3]

The PrepCom will have to develop procedures for standardizing analytical instruments for use in inspections, Some analysts worry that monitoring instruments might be abused for purposes of industrial espionage. According to one scenario, a monitoring instrument might be built with a covert microelectronic memory chip that would store all the raw data from a sample analysis. Later on, the data stored on the chip could be read out to identify proprietary chemical components present in the sample. In order to mitigate such concerns, instruments must be designed such that no nonvolatile memory can be taken from the inspection site without the approval of plant officials. More generally, all analytical instruments used in CWC inspections will need to be certified and maintained by the OPCW and checked by the inspected State Party before being brought onsite. Standardization (or at least prior approval) will also be necessary to ensure that instrumentation used in the inspections does not pose a safety hazard.[4]

NONINTRUSIVE VERIFICATION TECHNOLOGIES

One way to mitigate the conflict between warrantless inspections and Fourth Amendment privacy rights would be through the development of 'constitutionally nonintrusive verification technologies. Since Fourth Amendment protections do not extend to evidence of illegal conduct (e.g., drug smuggling), the Supreme Court has ruled that a warrantless search may be constitutionally permissable if it is performed with a highly selective monitoring device that can detect an illegal activity without picking up collateral information.[6] For example, a suspicious package can be searched for illegal drugs without a warrant if the search method (e.g., sniffing by a trained dog) indicates only the presence or absence of contraband, without revealing any additional information or exposing personal items that would otherwise remain hidden from public view.[7] Thus, onsite inspections would not contravene the privacy protections of the Fourth Amerndment if the monitoring instruments were highly selective for evidence of a treaty violation, while minimizing access to collateral information.

So-called "blinded' instrumentation involves the use of special software to indicate only whether or not a sample contains treaty-controlled chemicals. Extremely sensitive analytical instruments, such as a combined gas chromatograph/mass spectrometer (GC/MS), can detect trace amounts of CW agent byproducts in samples taken from a plant's production line or waste stream. (Waste stream samples must be taken before or shortly after the effluent is discharged into a river, where dilution can rapidly exceed the detection threshold.) A GC/MS normally displays the spectral peaks of unknown compounds on the screen and matches them with a computer against a stored library of reference spectra, yielding a list of candidate identifica-

[3] Kyle B. Olson, ''The Proposed Chemical Weapons Convention: An Industry Perspective, ' *Chemical Weapons Convention Bulletin, No. 3*, autumn *1988*, p. 3.

[4] The PrepCom will have to agree on the detailed technical parameters of all analytical instruments to be used during on-site inspections of chemical facilities.

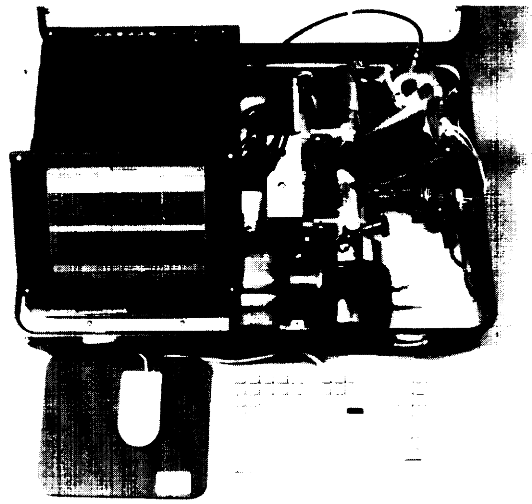
[5] Edward Tanzman and Rebecca Haffenden, "Constitutional and Legal Implications of Arms Control Verification Technologies," conference paper for the U.S. Defense Nuclear Agency Conference on Arms Control and Verification Technology, Williamsburg, VA, June 2, 1992, p. 3.

[6] Ibid, pp. 4-5.

[7] Ibid, p. 4.

tions. The results are given in terms of 'goodness of fit' according to a predetermined mathematical algorithm, and indicate the probability that a compound detected in the sample is the same as a reference compound. In principle, a blinded instrument would perform the computer matching without displaying the actual spectral data on the screen; the readout would indicate only which treaty-controlled chemicals were present in the sample. Although the raw data might indicate the presence of other, proprietary compounds, the operator would not have access to this information.

Critics note, however, that blinded instrumentation suffers from two technical drawbacks. First, since the output is normally expressed in terms of the probability of a match between the sample and the reference compound, it is almost always necessary for the analyst to examine visually the spectra of samples with a fit of greater than some predetermined probability and make a subjective judgment. Second, since the analysis would be limited to the list of known reference compounds programmed into the computer's memory, it would not detect novel or unusual CW agents. While one can program an analytical instrument to detect *families* of CW agents rather than specific compounds, even a large spectral library could not detect a supertoxic agent with an entirely new chemical structure, such as a rare biological toxin. Although a standard instrument would also be unable to match the spectrum of a novel CW agent to that of any known reference compound, the raw data might well suggest to the operator that a novel agent was present. For these reasons, blinded instrumentation may not provide an optimal solution to the problem of achieving effective verification while protecting proprietary information.



LAWRENCE LIVERMORE NATIONAL LABORATORY

Portable gas chromatograph/rnass spectrometer (GC/MS) developed to support onsite analysis for the Chemical Weapons Convention. This equipment can detect and identify minute quantities of organic chemicals controlled by the CWC.

UNATTENDED MONITORING EQUIPMENT

Some analysts contend that deploying unattended monitoring equipment in commercial chemical plants would help reduce the frequency and intrusiveness of onsite inspections, thereby saving scarce resources and reducing the verification burden on industry. Two proposals for the deployment of such devices are discussed below.

Continuous Monitoring of Production

Continuous surveillance of chemical-plant operations with permanently emplaced instruments may eventually offer a means to detect illicit CW agent production while minimizing the number of onsite inspections. Unattended monitoring stations would be controlled by a microcomputer and coupled to a safeguarded recording system for in-house record-keeping. Flow meters and other sensors would record the quantity of raw material that enters the reaction vessel, the amount of product leaving the vessel, and confirm the identity of the end-product.

Some chemical companies have begun using unattended monitoring stations to obtain a continuous record of plant operations in case a plant accident or spill leads to environmental or worker-safety litigation. In the context of CWC verification, unattended monitoring stations might be used to confirm that CW agents are not being produced and that the quantities of precursor chemicals moving through a plant are consistent with legitimate declared production. A precedent for this type of remote surveillance is the use by IAEA inspectors of unattended video recorders to monitor safeguarded nuclear facilities. With advances in communications technology, it is now possible to monitor plant operations from great distances by transmitting data over telephone lines or satellite links. An unattended monitoring station installed in a chemical plant might therefore be programmed to notify the OPCW Technical Secretariat in The Hague automatically when a suspected treaty violation occurred. Alternatively, the data could be recorded onsite and read out manually during routine inspections for comparison with the plant's own records.[8]

Unattended monitoring stations would be anathema to most of the U.S. chemical industry, however, if the stations were emplaced in critical process areas and were able to collect proprietary information, either inadvertently or deliberately. For example, if a proprietary catalyst were being used in a manufacturing process in the same plant as the synthesis of a scheduled chemical, an unattended monitoring station might pick up the catalyst in the plant atmosphere. Moreover, although the use of unattended monitoring stations might reduce the *frequency* of onsite inspections, it would not necessarily reduce their *intrusiveness.* The reason is that in order to set up the monitoring equipment, the inspectors would have to learn more about the chemical process being monitored than they would during a routine inspection.

Apart from industry objections, unattended monitoring stations have technical drawbacks that would complicate their use in CWC verification. At present, no entirely automated monitoring system is capable of guaranteeing the accuracy of the information it collects or of offering sufficient long-term consistency for fully remote operation. One difficulty is that the measuring instruments must be maintained and calibrated at regular intervals to ensure accuracy, In addition, all elements of an unattended monitoring station must be protected against intentional tampering, which can be very difficult to police. Changing the calibration of an instrument, for example, can make a large flow of material appear small. One way to minimize tampering is to enclose the instrument and transmitter in a secure box that can only be opened by authorized personnel, and to incorporate data-protection and authentication features to ensure that the signals being transmitted are from the actual monitoring instrument and not from a process simulator.[9]

Over the next several years, improved, self-calibrating instruments are likely to be developed that can function reliably for extended periods of time. Even so, considerable time and money would have to be spent to make such instruments tamper-proof, and such measures still would not preclude covert activities designed to bypass the instruments and violate the CWC.[10] For example, since multipurpose plants change their piping configuration fairly often, a cheater could install new feed pipes to divert chemicals around an online sensor or a reactor fitted with a continuous monitoring device. This circumvention scenario might be countered by inspecting the plant at regular intervals to ensure that deliberate repiping around sensors has not occurred. According to one chemical verification expert, however, instruments capable of useful continuous monitoring would be ''horrendously expensive and more

[8] Conference on Disarmament, "Report on a United States National Trial Inspection," document No. CD/922, June 22, 1989, p. 9.

[9] D. D. Drayer, cd., *Equipment for Potential Unattended Use in Treaty Verification Applications* (Albuquerque, NM: Sandia National Laboratories, report No, SAND-90-0572, May 1990), pp. 22-23.

[10] O. V. Perroni, "Possibilities for Automatic Monitoring of Chemical Products, " in S. J. Lundin, cd., *Non-Production by Industry of Chemical-Warfare Agents: Technical Verification Under a Chemical Weapons Convention, SIPRI Chemical & Biological Warfare Studies No, 9 (New* York, NY: Oxford University Press, 1988), p. 101.

intrusive than inspections, " while instruments of lesser capability and cost would not provide reliable data.[11]

| Automatic Sampling Systems

As an alternative to fully unattended monitoring stations, automated sampling devices might be installed in chemical plants at established points along the production line. The frequency of in-line sampling could be determined by the inspectors, and might be conducted on a random basis or in accordance with the inspection schedule.[12] One such approach, known as ''Sample Now, Analyze Later" (SNAL), involves taking samples automatically from the production line at random intervals, The collected samples would then be analyzed once or twice a year during a routine onsite inspection.[13]

A prototype SNAL device, developed by a team at the University of Hamburg, can store 1,200 samples over a period of a year on a single polyethylene cassette tape. The device extracts a few micrograms of material directly from the production line through a silicon transfer membrane and deposits the sample on a magnetic cassette tape along with data on the location, date, and time of the sampling. The polyethylene tape can be stored for long periods under conditions that preserve the sample. Several months later, inspectors can use a portable instrument to analyze the sample and read the associated data.[14] Nevertheless, industry may resist the installation of SNAL systems, which could also be vulnerable to tampering or circumvention.

In sum, because of the drawbacks of automated monitoring and sampling systems, exclusive reliance on such systems will not 'square the circle' of ensuring effective verfication while protecting legitimate industrial secrets. Nevertheless, the limited use of such systems in conjunction with routine inspections could help reduce the intrusiveness and frequency of onsite visits needed to verify the nonproduction of CW agents.

---

11 Raymond R. McGuire, Treaty Verification Office, Lawrence Livermore National Laboratory, personal communication, May 13, 1993.

12 Yuri V. Skripkin, ''Some Technical Aspects of Verification of the Non-Production of Chemical Weapons in the Chemical Industry,'' in S. J. Lundin, cd,, *Verification of Dual-use Chemicals Under the Chemical Weapons Convention: The Case of Thiodiglycol, SIPRI Chemical & Biological Warfare Series No. 13 (New* York, NY: Oxford University Press, 1991), pp. 120-123.

13 A. Verweij and H. L. Boter, ''Verification of Non-Production of Chemical-Warfare Agents in the Civil Chemical Industry," in S. J. Lundin, cd., *Non-Production by Industry of Chemical- Warfare Agents: Technical Verification Under a Chemical Weapons Convention, SIPRI Chemical & Biological Warfare Studies No. 9* (New York, NY: Oxford University Press, 1988), p, 94.

14 Gerhard Matz, University of Hamburg, ''Sampling Organics on a Magnetic Tape Reporter System for Retrospective Analysis by a Mobile Mass Spectrometer, " paper given at the Chemical Weapons Convention Verification Technology Research and Development Conference, Herndon, VA, Mar. 3, 1993.