

Impact of the scientific and technological development on the Chemical Weapons Convention: Threats and benefits

JIRI MATOUSEK [1]

EU Research Centre of Excellence for Environmental Chemistry and Ecotoxicology,
Faculty of Science, Masaryk University Brno, CZ-625 00 Brno, Czech Republic
e-mail: matousek@recetox.muni.cz

INTRODUCTION

Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction, shortly depicted as Convention on general and comprehensive prohibition of chemical weapons, or Chemical Weapons Convention, abbreviated as CWC was adopted in 1992 after complex negotiations on the soil of Conference on Disarmament (and previous multilateral negotiating fora in Geneva). The negotiations had lasted nearly a quarter of century not only due to then proceeding East-West confrontation and the Cold War but primarily due to existing doubts on possibility of achieving verifiable ban of chemical weapons (CW) because of the worldwide spread of chemical industry and relatively easy possibility of clandestine synthesis of chemical warfare agents in militarily relevant quantities. Mainly this problem but also bad experience with previously adopted Convention on the Prohibition of Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and of Their Destruction, abbreviated as BTWC (opened for signature in 1972, entering into force in 1975), lacking in the first line any objective verification mechanisms, has been reflected by very careful definitions and criteria, precisely defining purposes not prohibited by the Convention and mainly by very sophisticated verification system. The CWC is by no doubt the best elaborated disarmament document, totally outlawing one important and very dangerous kind of weapons of mass annihilation, committing the States Parties (SP) to destruction of the CW stockpiles and production facilities (CWPF). Ten years after opening for signature and six years after entry into force (EIF), the First Conference of the SPs reviewing operations of the CWC was convened in the The Hague, stating generally good acceptance by the international community, showing positive results of implementation of the CWC provisions, and defining the course for future.

Even if any arms control and disarmament document possesses military, military political, political, legal, military technological, scientific and technological aspects, the technical issues always dominate. The weapons and weapons systems concerned are the result of scientific and technological development *per se* and expected scientific and technological development must be envisaged already in the arms control and disarmament documents. This is valid especially in case of the CWC due to continuously appearing myriads of new toxic compounds and spread of chemical industry. The issue of scientific and technological development has been reflected already in the CWC in a very sophisticated manner, but it is necessary to assess the impact of both faces of scientific and technological development (i.e. threats and benefits) for the future of the CWC.

CHEMICAL WEAPONS CONVENTION – BASIC FACTS

Chemical Weapons Convention (CWC), opened for signature in Paris, on January 13, 1993 entered into force on April 29, 1997. Its complexity is reflected in almost 200 pages of text, containing Preamble and 24 Articles and three Annexes: On Chemicals (6 p), On Implementation & Verification (105 p), On Protection of Confidential Information (5 p) [2].

The genie of this Convention lies *inter alia* mainly in the mood of defining the scope of the prohibition. The CWC is rather purpose than compound oriented. This means that it is nothing like a list of prohibited compounds as some less informed people could expect. The leading principle, which is often reported as General Purpose Criterion (GPC) is contained in the wording of Article II, para 1, defining the purposes of the CWC among “Chemical Weapons”:

Article II DEFINITIONS AND CRITERIA

For the purposes of this Convention:

1. “Chemical Weapons” means the following, together or separately:
 - (a) Toxic chemicals and their precursors, except where intended for purposes not prohibited under this Convention, as long as the types and quantities are consistent with such purposes
 - (b) Munitions and devices, specifically designed to cause.....
 - (c) Any equipment specifically designed for use.....

Toxic chemicals are further defined in Article II para 2 as meaning

“Any chemical which through its chemical action on life processes can cause death, temporary incapacitation or permanent harm to humans and animals.

This includes all such chemicals, regardless of their origin or of their method of production and regardless of whether they are produced in facilities, in munitions or elsewhere”.

(The purposes, not prohibited under the CWC defined in Article II para 9 (a)-(d) encompass explicitly defined industrial, agricultural, research, medical, pharmaceutical or other peaceful purposes, protective purposes, military purposes not connected with use of CW and law enforcement including domestic riot control.)

From this explanation, quoting relevant articles of the CWC is evident, consistent with the mentioned GPC that the Convention:

- a) is nothing like a list of prohibited compounds,
- b) covers *any* toxic chemical intended to be used for chemical warfare (and therefore developed, produced and stockpiled), pursuant to Article II, para 1 (a) and para 2, i.e. even those not yet synthesised. This means that the CWC is open-ended and the prohibition covers any scientific and technological development.

The CWC lists (as the verification instrument) the most important toxic chemicals and their precursors, endangering the CWC within Three Schedules, constituted according to the risk these chemicals pose for the Convention. Schedule 1 thus contains super-toxic lethal chemicals and key precursors that have no peaceful uses, Schedule 2 contains dangerous toxic chemicals and precursors produced in small quantities with some peaceful use, and Schedule 3 lists widely used toxic industrial chemicals (that were in the former history used for chemical warfare) and precursors produced on mass scale. A frequent misunderstanding occurs considering the Schedules as the lists of “prohibited compounds” although it is clearly stated in the CWC that “Schedules do not constitute a definition of CW”.

The open-ended prohibition however does not mean that toxic chemicals (both scheduled and new non-scheduled) cannot appear on battlefields being used by non States Parties or less

possibly by SPs breaching the CWC or more possibly by the terrorist groups. That is why the scientific and technological development is to be very cautiously watched, international verification measures extended, national authorities and operation systems established, and respective national legislation adopted in order to enable prevention and adequate response in real time (repression, protection, rescue and recovery) in cases of emergency.

STATUS OF IMPLEMENTATION OF THE CHEMICAL WEAPONS CONVENTION

If it is not otherwise stated, the data on implementation are reported as of October 25, 2003.

- At present, there are altogether 155 States Parties to the Convention. Important is the membership of all P-5 members of UN Security Council and vast majority of states with declarable CWC facilities.
- Four SPs (Russia, USA, India and South Korea) declared possession of CW.
- Among SPs, there are 11 possessors of former (after 1946) CW production facilities (CWPFs), i.e. Russia, USA, India, South Korea, France, UK, China, Iran, Japan, Bosnia & Hercegovina and Serbia & Montenegro (last two SPs declared one, i.e. the same CWPF).
- The CWC implementation & verification regime now covers 90 % of world's population, but what is more important, 98 % of world's chemical industry.

Reviewing the figure on the number of SPs, it is also important to mention that there are 24 signatory states that have not yet ratified (*inter alia* Israel) and altogether 15 countries that have not even signed. Among them are North Korea and the neighbours of Israel (Egypt, Iraq, Libya, Lebanon and Syria), bounding their signature on the Israel's withdrawal from its nuclear weapons programme.

Assessing the universality of the CWC (as required by the 1st Review Conference), one can come to interesting results comparing this demand with the status of other principal agreements on weapons of mass destruction (WMD) as can be demonstrated by table 1.

Table 1. Universality: CWC compared with other main agreements on WMD

Treaty	Entry into force	SPs	other signatories	non-signatories
NPT	1970	187	---	7
BTWC	1975	143	17	34
CWC	1997	155	24	15

It seems that one could be satisfied with relatively high number of SPs, six years after EIF in comparison with other presented arms-control / disarmament agreements. Nevertheless, for the prevention of any use of CW, it is necessary to reach higher number of SPs mainly because most of the above mentioned important non-SPs concentrated in Near and Middle East and on Korean peninsula are supposed with high probability (nearly certainly) to be possessors of CW (not to speak on possession of other WMD like in the case of Israel).

The worldwide status of CWC implementation is witnessed by another important data:

- 145 initial declarations (on possession / non-possession of CW) were obtained from SPs,
- 124 National authorities were established in the SPs.

Especially the latter number seems to be still insufficient taking into consideration the tasks of such governmental office in the national implementation measures starting with the respective legislation and responsibility for total and comprehensive prohibition that needs supervision of the domestic chemical industry and any cooperative activities with the Organisation for the Prohibition of Chemical Weapons (OPCW).

The most important data from the declarations of SPs (see table 2) show the worldwide problems with possession, storage, former production of CW as well as with the spread of chemical industry

as the point of outcome not only for the destruction of CW at present and in the near future but for monitoring the non-production of CW by chemical industries in future.

Table 2. Important data from the declarations by the SPs

Subject	Declaring SPs	Declared sites
CW storage facilities (CWSFs)	4	33
CW destruction facilities (CWDFs)	4	39
CW Production Facilities (CWPFs)	11	61 ^a
Abandoned CW	3	16
Old CW	9	37
Schedule 1 Chemicals	21	26
Schedule 2 Chemicals	33	437
Schedule 3 Chemicals	33	496
Discrete Organic Chemicals	60	4117

^a Of the 61 reported former CWPFs, 32 have been already destroyed & converted

The total number of declared sites (5262) which are to be regularly or randomly inspected shows the high burden of expected verification activities. At this stage of implementation, the verification activities have been obviously mainly concentrated on storage and destruction, and in industry on facilities producing scheduled chemicals. At present, the most important activity in implementation of the CWC is destruction of CW:

Declared chemical agents destroyed (July 2003)	69,883 tonnes
Declared munitions (containers) destroyed (July 2003)	7,697 tonnes
	8,625,219 items
	1,929,971 items

As expected, the destruction is proceeding asymmetrically, meeting domestic financial and technological problems with construction of destruction facilities and their acceptance by population. So, e.g. Russian Federation destroyed 400 tonnes (about 1 %) of its stockpiles as it had promised to do so to the 1st Rev. Conf. It is therefore expected, that the scheduled 10 years term for total CW destruction according to the CWC will not be managed and the allowed exemption to extend the destruction period for another 5 years will certainly be asked for. By the way, the latest reports of the USA show the similar. Most important is that the destruction process has been accelerated at present.

ORGANISATION FOR THE PROHIBITION OF CHEMICAL WEAPONS - OPCW

Pursuant to the CWC, after its signature, the Preparatory Commission was founded and after EIF the Organisation for the Prohibition of Chemical Weapons (OPCW) with the seat in The Hague (Johan de Wittlaan 32, 2517 JR Den Haag) was established. For more information see <http://www.opcw.org>.

The Organisation consists of three main constitutive elements:

- a) Conference of the State Parties (all SPs, meet regularly once a year), present Chair: H.E. Amb. Nouredine Djoudi (Algeria).
- b) Executive Council - EC (41 members distributed among the SPs on a regional, rotating base for 2 years term, meets regularly 4 times a year), present Chair: H.E. Amb. Petr Kubernát (Czech Republic).
- c) Technical Secretariat - TS (516 staff members, of them about 200 inspectors),

Director General: H.E. Amb. Rogelio Pfirter (Argentina),

- Subsidiary bodies: Scientific Advisory Board (20 independent experts),
Confidentiality Commission,
Advisory Board on Administrative and Financial Matters.

THE FIRST REVIEW CONFERENCE

The character and tasks of the Conference (May 2-9, 2003) were determined as follows:

- Review operations of the Convention,
- Take account of scientific and technological development,
- Lessons learned and recommendation for future implementation,
- Not an amendment (revision) conference.

The attendance represented 113 SPs, 2 signatory states (Haiti, Israel), 2 non-signatory states (Libya, Angola), 5 International Organisations (ESA, ICRC, PCA, CTBTO and UNIDIR), 22 NGOs and 6 Industry Associations.

The Conference did not result in radical change of direction for the OPCW or substantive decisions on crucial, still outstanding issues (e.g. so called “non-lethal” agents, riot-control agents, “law enforcement”, nil declarations in respect of OCPFs and like. A number of priorities have, however been clearly recognised.

To the priorities stressed by the First Review Conference belong:

- Universality of the Convention,
- National implementation measures,
- International Cooperation and Assistance,
- Verification regime for the chemical industry
- Optimisation of verification measures
- Scientific and technological development and
- Functioning of the OPCW.

The detailed explanation goes beyond the frame of this paper. For further information see the adopted documents. This is in the first line the Political declaration containing 23 paras [3] and the main written result, i.e. the Review document with 134 paras [4]. Except general notions on science and technology, expressed in nearly all presented statements by SPs, the programme did not go too deep into the problems of impact of scientific and technological development on the CWC that are obviously connected with its future implementation. This problem was however analysed in the document prepared by the OPCW Scientific Advisory Board introduced in the Note by the Director General [5]. It is generally expected that this will mainly influence future activities of the OPCW.

MAIN PILLARS OF THE CONVENTION AND IMPACT OF SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

To the main pillars of the CWC belong:

- Verified destruction of chemical weapons (CW) and CW production facilities (CWPF),
i.e. *disarmament*,
- Verified non-production of CW, i.e. *non-proliferation*,
- Assistance and Protection,
- International Cooperation.

It is obvious that scientific and technological development may have both positive and negative impact on the CWC and its implementation. The positive impact is connected with destruction technologies, utilisation of sophisticated Hi-Tech analytical equipment and methodologies for all objective verification activities and in all branches of equipment and

measures and know-how connected with assistance and protection. On the other hand, the scientific and technological development represents threats in rapid pace of synthesis and of both scheduled and mainly non-scheduled chemicals that are, as a matter of fact prohibited according to the GPC which does not mean that they cannot appear on battlefields being used by non-SPs or by SPs breaching the CWC or at terrorist strikes.

CONTRIBUTION OF THE SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT ON THE DESTRUCTION OF CHEMICAL WEAPONS

The destruction and disposal methods, routinely used for elimination of obsolete chemical arsenals (used on the mass scale mainly for elimination of German and Japanese chemical arsenals after the WW-II), i.e. sea dumping, earth burial, open-pit burning or blasting, were used till the 1970s. The last known event of this art was the operation CHASE, when the US dumped obsolete munitions filled with nerve agents. Such procedures became gradually unacceptable due to the environmental awareness and respective domestic legislation. Therefore, R&D of new technologies was started in the 1970s in the connection with upgrading chemical arsenals, long before destruction pursuant to the CWC and even its drafting were commenced. It is obvious that the most common technology for destruction of waste chemicals by incineration was the first principal technological orientation.

Short overview of technological procedures suggested, tested and operational since this time is shown in table 3.

Table 3. Short overview of suggested technological procedures for destruction of CW

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- o Two-Stage Technology (Soviet) – chemical deactivation + detoxification (operational)
 - o Incineration, e.g. JACADS (Johnston Atoll Chem.Agent Disposal System) (operational)
 - o Underground nuclear explosion – Arzamas 16 (according to Acad. Trutnev)
 - o Disproportionation using decommissioned liquid propellant missile engine (Acad. Plate)
 - o Biological methods – e.g. biodegradation of organophosphates
 - o Supercritical water oxidation
 - o Wet air oxidation
 - o Molten salt processes
 - o Photochemical processes
 - gas phase process (photochemical)
 - aqueous phase process
 - ozone/UV irradiation
 - laser-stimulated photodegradation
 - catalytic ozone oxidation
 - gamma irradiation
 - o Electrochemical techniques
 - o “Neutralisation”: hydrolysis, oxidation etc.
 - o Chemical reprocessing : chlorolysis, catalytic dehydrochlorination
 - o Thermic processes:
 - plasma reactors (operational)
 - microwave plasma processes
 - IR thermal process
 - radiofrequency thermal process
 - o Solvated electron technology
 - o Specific techniques for destruction of arsenicals (operational)
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Presented list of techniques encompass also some curious procedures, like the underground nuclear explosions, certainly very effective but hardly acceptable because of posing other risks and inability to safely check the end-point of the destruction as required by the CWC, or the otherwise attractive proposal by N. Platé, able to simultaneously destroy two armament kinds designated to disarmament pursuant to the CWC and bilateral IMF Agreement (USA-USSR). It can be noted that according to the theoretical considerations or/and actual experience with some operational technologies, there are attempts to assess the available and potential alternative technologies taking into consideration all technical, economic as well as health and environmental aspects [6,7]. These studies are oriented to proven realistic technologies. Interesting review assessment contains the only study on alternatives to incineration, considering mainly toxicity of end-products [8].

THREATS OF THE SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT ON THE POTENTIAL PROLIFERATION OF CHEMICAL WEAPONS

One present problem lies already in the inconsistency of the CWC with regard to the riot-control agents. Even if the law enforcement and domestic riot control are explicitly mentioned among purposes non prohibited by the Convention, the particular article (Article I, 5), dealing with prohibition of using riot-control agents as a method of warfare is generally considered as *ipso facto* exempting riot-control agents from the definition of toxic chemicals (for the purposes of the CWC) and thus also from the current verification regime because these agents are unscheduled. This is a significant loophole in the CWC, allowing its circumvention because R&D and production of this class of chemicals are out of any verification measures. One can imagine legitimate search for new effective and safe (how safe?) irritants and incapacitants for police purposes but also temptations for uncontrolled production of means that might once occur on the battlefield. This is an actually existing problem of very dangerous orientation on the so called “non-lethal” agents. Every toxicologist however knows very well that toxic effect or response of organism is dose- (exposition-) dependent. That means that something like non-lethal agents do not exist at all. Safety index of irritants (incapacitants and like) depends on the difference between (statistically determined) dose (concentration) with intolerable effects and dose (concentration) causing death. This index should be as big as possible at the riot-control agents but it is in its nature that it cannot be unlimited, that is why the thesis on “non-lethality” is an actual mystification if not cheating.

The future threats are mainly given by the changing face of synthetic and manufacturing methods for production of both scheduled and new toxic compounds among unscheduled chemicals. It is mainly rapid pace of development in biomolecular science (e.g. genomics and proteomics) and in synthesis (i.e. combinatorial chemistry) giving rise of appearing new toxic chemicals for potential misuse. These methods enable to synthesise the whole series of “tailored” structures (i.e. with theoretically predicted effects) very quickly. That was lasted months to years in the half of the 20th century, can be achieved within days to weeks now.

We are now faced also with changed character of chemical industry. Many parts of chemical industry operate with multipurpose batch facilities which can readily be switched from one product to another. The potential of producing toxic chemicals is considerably enhanced by the use of micro-reactors producing large volumes in small plants. Globalisation of this industry needs thus reviewing verification regime of “other chemical production facilities” (OPCF). The ever-growing range of toxic chemicals and new processes of small-scale syntheses increase also threat of chemical terrorism.

BENEFITS OF THE SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT ON VERIFICATION OF IMPLEMENTATION OF THE CWC

The main benefit of scientific and technological development for verifying provisions of the CWC is given by the possibility to use objective rapid developing analytical methods and Hi-Tech instrumentation. Many modern separation techniques (such as GC or HPLC) coupled with identification techniques (such as MS) and other spectrophotometric methods (e.g. FT-IR) with computerised data-libraries accessible on-line have been introduced in the OPCW- designated laboratories and some of them are routinely used in portable or mobile equipment for the on-site inspections. The problem is follow-up the development of potential toxic chemicals (mainly those unscheduled), technical upgrading of equipment, analysis of toxins and biological samples, conservation and transportation of samples for off-site analysis and like. It is also desirable to introduce utilisation of automatic analytical techniques, including remote (off-site) methods with automated data transmission in real time to enable decreasing the burden of continuous on-site presence of inspectors verifying destruction of CW. It is obvious that implementing the CWC needs already nowadays shift of the verification effort from the destruction to much higher future threat, i.e. non-production of CW by the peaceful chemical industries, producing discrete organic chemicals. This multifaceted technical issue of verification with many practical applications for various verification tasks significantly extend the scope of this article. It can be however concluded that the power of modern analytical science, if it were used in full extent, all analytical requirements of the CWC could be achieved.

CONTRIBUTION OF THE SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT ON ASSISTANCE AND PROTECTION

Incorporating Article X (Assistance and Protection) into the CWC was very important. Threat of CW use exists from the non-SPs, SPs till the full destruction, than also from old and abandoned CW, not to speak about terrorist use of toxic chemicals. But protective equipment will be necessary also on the battlefields not only at use of CW and other WMD. Even destroyed industrial and social infrastructures of modern civilised societies, releasing toxic, inflammable, explosive, radioactive and infectious materials on landscape, densely populated with such infrastructures after strikes with conventional weapons need protective equipment Similarly like at events occurring in the peacetime as a result of accidents caused by personal, material or system failure or terrorist strikes.

Assistance and protection according to the Article X of the CWC envisages providing equipment and know-how, currently developed, produced and used by Chemical Corps and Civil Protection and upgraded for the needs of CWC implementation. Assistance and Protection encompass technical issues, shortly summarised in table 4.

Table 4. Equipment and know-how implied under Article X (Assistance and Protection)

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- o Detection, identification and monitoring
 - point detection (simple means, automatic alarms, reconnaissance vehicles)
 - stand-off detection (stand-off detectors, remote monitoring, data transmission)
 - field analysis (portable and mobile laboratories and sets)
 - o Decontamination
 - decontamination of personnel (personal sets, sets and equipment on higher echelons)
 - decontamination of equipment & materiel (3 levels: individual, squad, special units for decon of heavy, sensitive etc. military weaponry and equipment)
 - decontamination of stationary objects (terrain, buildings and other structures)
 - decontamination and treatment of water (portable, mobile and stationary facilities)
 - o Protection of personnel
 - individual protection (protective masks, suits, accessories and other means for arms, civil protection and population of all age groups, both for general use and for specialists)

- collective protection (shelters, filtration & ventilation and other special equipment, protected mobile means)
 - o Treatment of intoxications
 - first aid (antidotes, syringes, autoinjectors, decon means)
 - medical treatment (antidotes, therapeutic procedures, equipment, evacuation and rescue systems, mobile means).
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OTHER CHALLENGES OF SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT

Among other challenges the scientific and technological development pose, mainly those for the OPCW Technical Secretariat (TS) as well as those connected with education and outreach can be mentioned.

Rapid pace of development of new unscheduled chemicals and new production processes needs the TS to be kept up to date. This needs to continuously review relevant scientific and technological development. In this connection, it seems reasonable to further work with the recommendations of the Scientific Advisory Board, as contained in the Note by the Director General [5]. It can be stressed that in the area of verification, for sampling and analysis only highest standards in the TS and designated labs are necessary. This refers in the first line on equipment, training and of course necessary resources devoted to this crucial responsibility of the TS.

Not only future scientific and technological development but in the first line the CWC as such and its profound knowledge and correct interpretation should be matter of education and outreach to the scientific and technical communities, as well as to political decision-makers in SPs, SS and nSSs. It is necessary to extend cooperation with relevant national and international professional organisations like academiae, universities, industry associations and last but not least also NGOs representing concerned engineers and scientists that have also heavily contributed to the CWC in the times it was negotiated and even later in the times of access and ratification process as well as nowadays during its implementation and assessing impact of scientific and technological development

CONCLUSIONS

Operations of the Chemical Weapons Convention are proceeding satisfactory judging according to the status of its implementation by 155 States Parties and verification by the Organisation for Prohibition of the Chemical Weapons in The Hague six years after entry into force. The First Review Conference stressed the importance of achieving worldwide universality in order to totally eliminate the dark heredity of past chemical arsenals once forever, prevent threats and utilise benefits of the scientific and technological development for the CWC implementation in the foreseeable future.

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