The Chemical Weapons Convention and the Role of Engineers and Scientists*

KUI – 4/2010
Received January 8, 2009
Accepted November 4, 2009

J. Matoušek

EU Research Centre of Excellence for Environmental Chemistry and Ecotoxicology, Faculty of Science, Masaryk University, Brno, Czech Republic

Chemical weapons, like all military technology, are associated with activities of scientists and engineers. However, chemical weapons differ from any other military technology because they were invented, and their first mass use directly developed by famous chemists. The active contribution of engineers and scientists and their organisations in the negotiations on chemical disarmament, including drafting the Chemical Weapons Convention, is described. Their present and future role in implementing the Convention is analysed, taking into consideration the threats and benefits of advances in science and technology, and stressing the independent expertise of the OPCW Scientific Advisory Board.

Keywords: *Chemical Weapons Convention, engineers, scientists, NGOs, advances in science and technology, OPCW Scientific Advisory Board*

Introduction

The Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction, referred to briefly as the Convention on General and Comprehensive Prohibition of Chemical Weapons, or Chemical Weapons Convention, abbreviated as CWC, was adopted in 1992 after negotiations at the Conference on Disarmament (and previous multilateral negotiating fora in Geneva) which lasted nearly a quarter of a century. The delays were due not only to the then current East-West confrontation and the Cold War but also to the worldwide spread of the chemical industry and the relatively easy possibility of clandestine synthesis of chemical warfare agents in militarily-relevant quantities. This experience, and also experience with weak points of the previously adopted Convention on the Prohibition of Development, Production and Stockpiling Bacteriological (Biological) and Toxin Weapons and of Their Destruction (BTWC),** which lacked any objective verification mechanisms, has been reflected in very careful definitions and criteria, defining purposes not prohibited by the CWC, and a very complex and effective verification system. This is a very sophisticated and by no doubt also the best elaborated disarmament document that totally outlaws one important and very dangerous kind of weapon of mass destruction (WMD). It commits States Parties (SP) to eliminate their chemical weapon (CW) stockpiles and production facilities (CWPF). Both Review Conferences (2003 and 2008) reported generally good acceptance by the international community, showed positive results of implementation of the CWC provisions, and outlined future actions.

Any arms control document, as for any functioning disarmament agreement, even if it is primarily a document of international law, is much more than just a legal document; it has political, military, military technological, military political, scientific and technological, economic, ethical and such like aspects also. It can be adopted and implemented only as a result of wide consensus of the international community, while it cannot exist without expertise in all the above-mentioned areas.

The coherent formulation and concise regime of the CWC reflects the extremely valuable and effective contributions of well informed and concerned engineers and scientists and their national and international professional organisations. The latter include NGOs mainly in chemistry, chemical technology and allied branches associated with the development, production, use and protection against CW and other WMD. This paper describes the efforts made by the scientific and technological community to achieve a verifiable total and comprehensive ban of CW from the start of negotiations about the CWC, discusses activities involved in implementing the CWC as well as future tasks arising from the impact of scientific and technological development.

The Route to the Chemical Weapons Convention and the Contribution of the International Community of Engineers and Scientists

Beside the positive role of engineers and scientists in any arms control and disarmament issue, their negative role should also be mentioned. Any weaponry must have been

* Based on J. Matousek's lecture at a NATO Advanced Research Workshop, 13–16 November 2008, Zagreb, Croatia, organised by the British and Croatian Pugwash Groups. The text is a chapter of the book resulting from the workshop: "Assessing the Threat of Weapons of Mass Destruction – The Role of Independent Scientists", edited by L. Finney and I. Šlaus, IOS Press, Amsterdam 2010. Permission from IOS Press is gratefully acknowledged.

** Opened for signature in 1972, entered into force in 1975.

designed by scientists and engineers at the relevant stages of scientific and technological development in their professional service in order to solve concrete demands for developing the technology of warfare. Mass use of chemical weapons could emerge only in the era of a chemical industry capable of delivering enough quantity of toxic chemicals (initially chlorine and phosgene) routinely produced as basic raw materials for syntheses of organic chemicals (originally organic dyestuffs). This prerequisite was most developed in Germany, which produced more than 90 per cent of the world production of synthetic dyestuffs in the second decade of the 20th century. The possibility of misusing this potential for weaponry was actually transformed into reality just shortly after the initial stage of the First World War (WW I) when the movements of big armies were stopped in the mud of the trenches. This was the impetus for developing new weapons able to overcome field fortifications. Chemical weapons with their widespread effects appeared on battlefields exactly at that time.

It is typical, maybe only for chemical weapons, that they were not developed by any order of the military, and in this case also not following a wish of Emperor Wilhelm II. Rather, the first use of pernicious chemicals* had been designed and developed from the original idea of scientists. The actual 'Father of Chemical Warfare' was Professor Fritz Haber (later Nobel laureate in chemistry for the synthesis of ammonia), then director of the Emperor Wilhelm Institute of Physical Chemistry and Electrochemistry in Berlin-Dahlem. He put together a staff of excellent scientists (among them some well-known Nobel laureates) – James Franck, Gustav Hertz, Wilhelm Westphal and Richard Wilstätter – for designing scientifically the first use of chemical weapons. Industry was also represented – Professor Carl Duisberg, director of IG-Farben, was also a member of this group under Haber's personal leadership. The idea for the first use (called *Blasangriff* in German) was the release on a wide front of gaseous chlorine from steel bottles.

There is another interesting piece of evidence for the personal responsibility of Fritz Haber. Emperor Wilhelm asked Haber whether Germany's international obligations would be breached by such use. It should be noted that the Declaration of the Peace Conference in The Hague, signed on July 29, 1899, contained an obligation for States Parties "not to use such projectiles, the only purpose of them is to disseminate asphyxiating or deleterious gases". Furthermore, the Appendix of the IV Convention on the Principles of War on Land, signed in The Hague in 1907, contained in its Article 23 explicit prohibition of "use of poison or poisoned weapons".

Haber convinced the Emperor that "no munitions would be used"; thereby any doubts were diverted and preparations continued. Their result was the first mass use of chemical weapons by the Germans at Ieper (Ypres) in West Flanders on April 22, 1915, with the release of 168 metric tonnes of gaseous chlorine from steel bottles. The effect of this first act of chemical warfare was horrible: 15,000 casualties, among them 5,000 lethal ones, on the side of the British, French and Belgian Allies. By walking behind the green-greyish toxic plume, the German infantry penetrated 4 km into the depth of the enemy's defence positions without firing a single shot. However, the military effect was greater than expected, so that chlorine was not utilised to try to break through the full depth of the Entente's defence system. Having seen a new effective weaponry being used, none of the belligerents protested against chemical warfare. Quite the opposite: all other major belligerents, mostly SPs to the above-mentioned agreements (France, Russia, Austria–Hungary, Italy, USA), gradually accepted this mode of warfare. Only the International Committee of the Red Cross (ICRC) protested in its appeal of 1918 against chemical weapons that became standard weapons in many other countries after WW I.

Shortly after constituting its foundation as the first universal international organisation, The League of Nations initiated the first negotiations for outlawing chemical weapons.

The first modern valid arms control document, the Protocol banning use in war of asphyxiating and other toxic gases and bacteriological methods of warfare,** prohibited only the use of chemical weapons but not material preparations for chemical warfare. This left open the possibility of retaliation-in-kind, and has been shown not to be an effective instrument for prohibiting any CW use. The Protocol was violated by some of its SPs several times, starting with the use in 1935 of CW by Italy (incidentally the first country to have ratified it) in Abyssinia (Ethiopia) in 1935, by Japan in China from 1937, and later by Iraq in the Iraq–Iran War in the 1980s. This Protocol was generally considered as prohibiting only the first use of such weapons because about one third of signatories ratified it with the reservation that they would not be bound by it in the case of the first use of CW by an adversary or its allies.

In the post-WW II era, the UN General Assembly started discussions on the total and comprehensive ban of chemical and biological weapons as early as 1946. The negotiations were commenced at the multilateral negotiating body, the Eighteen Nations Disarmament Committee in Geneva, and continued in its successor bodies until the later Conference on Disarmament (CD). The first efforts addressed both chemical and biological weapons but in the late 1960s the problem of biological weapons was separated off, as the latter was then (i. e. in the time of the classical era of biological warfare, when its possible military value had been underestimated) considered as more easily solved. This enabled relatively quick adoption of the BTWC in 1972, though with all its gaps and weaknesses as mentioned above.

The discussions and further negotiations on the main points of the future CWC started in the 1970s, while the deeper negotiations on its structure and contents commenced in the early 1980s. The CD had been precisely mandated by the UN General Assembly since 1984. The complex negotiations then lasted until 1992, after exploring many sidetracks, reflecting not only inherent difficulties of this issue but also the impact of the final years of the Cold War and East-West confrontation.

* Not to speak of the episodic use of irritants that had been started already in August 1914 by the French side, and was responded to several times by the Germans in 1914.

** Signed in Geneva, June 17, 1925; entered into force 1928.

The input of scientific and technological communities into the negotiations was undoubtedly crucial. Beside the personal engagement of military, scientific, technological and legal experts working in the national delegations who took an active part in the negotiations, with their backgrounds supported by domestic research institutes, academia, universities, industrial organisations and associations, and state offices, several prestigious international professional organisations of concerned scientists and engineers also contributed to the negotiations from their start.

Among the prestigious international and leading national (research) institutes, organisations and programmes making major contributions to discussing the problems of CW and BTW, the Stockholm International Peace Research Institute (SIPRI) occupies the prime position. SIPRI was founded to commemorate 150 years of unbroken peace in Sweden and it is known worldwide for its impressive research and publication activity. Its Chemical and Biological (CB) Warfare Programme began in the late 1960s and is now one of SIPRI's longest running programmes. Analyses devoted to various actual problems of chemical (CW) and biological and toxin weapons (BTW), and progress in BTWC and CWC negotiations and later in their implementation can be found in the respective chapters of all published SIPRI Yearbooks (since the first 1968/69) as well as in the series of *CB Warfare Studies* started in 1985, a couple of other previous and parallel books and other non-serial publications on various aspects of CW and BTW. These sources have been widely utilised as serious and fully reliable reference information by the whole community dealing with CB disarmament. The second most important programme relating to the old chemical and biological weapons (CBW) programme was obviously the Harvard Sussex Programme, which edited the quarterly *CBW Conventions Bulletin* (originally named *CWC Convention Bulletin*), another serious reference source on chronology, news, background information and comment on CBTW problems. The other institute worth naming is the United Nations Institute for Disarmament Research (UNIDIR) in Geneva.

There are also other programmes contributing to CB weapons issues that have been active mainly in the last decade. Among these one cannot overlook the NATO Partnership for Peace Programme nor the NATO Programme for Security through Science that have organised frequent Advanced Research Workshops devoted to various aspects of CB disarmament and have also undertaken relevant educational activities. Among the national institutes and organisations known for their activities in organising periodic international conferences, congresses and symposia devoted to the issues of CB warfare, the prime position belongs to the Swedish Defence Research Agency (FOI, but previously the Swedish Defence Research Establishment FOA) which organises the CBW Protection Symposia in Stockholm every three years. These meetings constitute the biggest worldwide gathering of specialists on this topic, the latest having taken place in Gothenburg in 2007. A similar, slightly smaller NBC (nuclear, biological and chemical) event is organised also every three years in Finland by the chemical defence organisations, the latest being the 7th (NBC–2009) in Jyväskylä. A related periodic gathering in the Asia/Pacific region, organised since the late 1990s by the defence institutions in Singapore, is known as SISPAT. One cannot overlook the very active US organisation with links worldwide, Applied Science and Analysis (ASA) Inc., which organises the annual series of Chemical and Biological Medical Treatment Symposia (CBMTS), the first being in Spiez, Switzerland in 1994 and the recent ones dealing with CBR (chemical, biological and radiological) terrorism. This organisation also edits the *ASA Newletter,* which has been an important information source on various aspects of NBC protection and related problems for two decades. A very important series of symposia fully devoted to the destruction of CW, i. e. CW demilitarisation, is organised yearly by the British Defence Scien- ce and Technology Laboratories (Dstl). Another institute worth mentioning is the Illinois Institute of Technology Research Institute (IITRI) which has since 1996 organised four workshops on CB Agents – Detection and Decontamination (three in Chicago, USA, one in Brno, Czech Republic headed by the author). It is impossible not to mention the valuable contribution of the International Union of Pure and Applied Chemistry (IUPAC) which in recent years has worked on destruction technologies. It has also worked on the actual problems of the impact of scientific and technological development on the CWC, including the developments in synthetic chemistry, problems of the changing face of chemical industry, developments in analytical chemistry, and verification issues. This latter issue is deeply studied also by the Verification Research, Training and Information Centre (VERTIC), an organisation that deals with all aspects of verification. It is impossible to name all the organisations and institutes that make positive input but associations of chemical industry should be mentioned also.

Among the prestigious international NGOs representing the community of scientists and engineers with an active input into CBW disarmament issues, pride of place belongs to the Pugwash Conferences on Science and World Affairs, founded in 1957. Especially engaged in critical discussions and open exchange of views and standpoints has been the Pugwash Study Group on CB Disarmament, linking independent experts with negotiators in the CD at meetings convened at least once a year since the 1960s, mostly in Geneva, then also latterly in the Netherlands. Several joint SIPRI-Pugwash publications also contributed strongly to the formulation of the CWC. In the mid–1990s this forum was renamed the Pugwash Study Group on Implementation of the Chemical (1993) and Biological (1972) Weapons Conventions. Meetings continue normally twice a year, assessing all urgent aspects of implementation of the two Conventions, including identifying threats of scientific and technological development on the futures of both the CWC and BTWC.

Another worldwide NGO of concerned scientists that made major contributions mainly in the time when the CWC was being negotiated is the World Federation of Scientific Workers (WFSW), which then had a very large membership. The WFSW edited the Journal *Scientific World,* and its Standing Committee on Disarmament published two studies on the threat of chemical weapons and chemical disarmament (1983, 1986). Each of these studies was published in four languages (English, French, German and Russian), and were edited in London, Paris, Berlin and Moscow (with the author's contribution). Total and comprehensive prohibition of CW has also been among the main goals of the International Network of Engineers and Scientists for Global Respon-

sibility (INES). This organisation was founded in 1991, with member organisations in about 60 countries on all continents. It contributes to the CW ban through its Working Group on Chemical Weapons (convened by the author), by dealing with this problem at INES events (for example the Workshop on CB disarmament at the INES Congress in Amsterdam, 1996), by the activities of its Council and Executive Committee, and by appealing to Parliaments to accelerate the ratification process to achieve the entry into force of the CWC in 1995. Important also are the links between, and representation of, the above-mentioned NGOs (mainly the WFSW) in the respective NGO Committees working in the headquarters of the United Nations (in New York, Vienna, and Geneva) to influence their engagement in the CB issues.

It is impossible to mention all institutions and organisations contributing to the CW ban (including also, for example, Greenpeace International and Green Cross) but there is no doubt that without the engaged expertise of concerned professionals and their organisations, and state, public and private, national and international organisations and fora including NGOs, a document as sophisticated as the CWC could not exist at all.

Chemical Weapons Convention – Basic Facts

The Chemical Weapons Convention opened for signature in Paris, on January 13, 1993 and entered into force on April 29, 1997. Its complexity is reflected in almost 200 pages of text, containing a Preamble, 24 Articles and three Annexes: On Chemicals (6 pp), On Implementation and Verification (105 pp), On Protection of Confidential Information (5 pp).[1]

The main pillars of the CWC are:

– Verified destruction of chemical weapons and CW production facilities; (CWPF), i. e. disarmament.

– Verified non-production of CW, i. e. non-proliferation.

– Assistance and protection.

– International cooperation.

The spirit of this Convention, significantly influenced by scientific expertise, lies *inter alia* mainly in the method of defining the scope of the prohibition. The CWC is rather purpose- than chemical compound-oriented. This means that it is nothing like a list of prohibited compounds, as some less informed people might expect. The Convention's leading principle, which is often reported as the General Purpose Criterion (GPC), is contained in the wording of Article II, paragraph 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…".

Under purposes non-prohibited by the Convention according to Article II, paragraph 2 (a) – (d) are understood:

"industrial, agricultural, research, medical, pharmaceutical or other purposes, protective purposes, namely those directly related to protection against toxic chemicals,

"military purposes not connected with the use of CW and not dependent on the use of toxic properties of chemicals as a method of warfare as well as law enforcement including domestic riot control".

Toxic chemicals are further defined in Article II paragraph 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".

From this explanation quoting relevant articles of the CWC, it is evident, consistent with the above-mentioned GPC, that the Convention is nothing like a list of prohibited compounds. It covers *any* toxic chemical intended to be used for chemical warfare (and therefore developed, produced and stockpiled), pursuant to Article II, paragraph 1 (a) and paragraph 2, *even those not yet synthesised*. This means that the CWC is open-ended and the prohibition covers any future scientific and technological development. In other words the Convention is *ipso facto* protected against the results of scientific and technological development.

The most important toxic chemicals and their precursors endangering the CWC are listed within three Schedules, constituted according to the risk the chemicals pose for the Convention. Schedule 1 contains super-toxic lethal chemicals and key precursors that have no peaceful uses, Schedule 2 contains dual-use dangerous toxic chemicals and precursors produced in small quantities, and Schedule 3 lists toxic industrial chemicals that have been used for chemical weapons and their precursors and produced on a mass scale.

A frequent misunderstanding is to consider the Schedules as something like lists of 'prohibited compounds', although it is explicitly stated in the CWC that "Schedules do not constitute a definition of CW". However, the open-ended prohibition does not mean that toxic chemicals (including other than those contained in the Schedules) cannot appear on battlefields being used by non-States Parties, or less possibly by SPs breaching the CWC, or more possibly by terrorist groups.

That is why scientific and technological development has to be very carefully watched, international verification measures extended, national authorities and operation systems established, and respective legislation adopted in order to enable prevention and an adequate and immediate response (repression, protection, rescue and recovery) in cases of emergency.

Implementation of the Chemical Weapons Convention and the Role of the International Community of Engineers and Scientists*

Facts about the Implementation of the CWC

At present, there are 188 States Parties to the Convention. It is important that the Convention includes all P5** members of UN Security Council and the vast majority of states with declarable CWC facilities.

Seven SPs (Russia, USA, India, Albania, South Korea, Libya and Iraq) declared possession of chemical weapons.

Among SPs, there are 13 possessors of former (post 1946) CW production facilities: Russia, USA, India, South Korea, Libya, France, UK, China, Iran, Iraq, Japan, Bosnia & Hercegovina and Serbia & Montenegro (the last two SPs declared one – i. e. the same – production facility).

The CWC implementation and verification regime now covers over 98 % of the world's population, but what is more important, 98 % of the world's chemical industry.

Reviewing the figure for the number of SPs, it is also important to note that there are 2 signatory states (*inter alia* Israel) that have not yet ratified the Convention and altogether 5 countries that have not even signed it. In addition to less important states it should be noted that to the non-signatories group belongs the Democratic People's Republic of Korea, and also that the neighbours of Israel (Egypt and Syria) made their signatures conditional on Israel's abandoning its nuclear weapons programme. Assessing the universality of the CWC (which is one of the requirements of the First Review Conference), it is interesting to compare the signatory states with those of other principal agreements on weapons of mass destruction (WMD) as shown by Table 1.

It seems that one could be satisfied with the relatively high number of SPs twelve years after entry into force, in comparison with other arms-control/disarmament agreements. Nevertheless, for the prevention of any use of CW, it is necessary to attain a higher number of SPs mainly because some of the above-mentioned important non-signatories concentrated in the Near and Middle East and on the Korean peninsula are likely possessors of CW (not to speak of possession of another WMD in the case of Israel and North Korea).

The most important data from the declarations of SPs (see Table 2) show the worldwide problems arising from the possession, storage and former production of CW, as well as from the spread of chemical industry. These problems affect not only the destruction of CW at present and in the near future but also the monitoring of the non-production of CW in the chemical industry in the future.

Verification of the destruction of CW stockpiles and of CW production facilities, as well as verification of non-production of CW by the peaceful chemical industry, is the concern of the main pillars of the Convention. The total number of sites declared by SPs that must be regularly or randomly inspected (over 5800) shows the heavy burden of necessary verification activities. At this stage of implementation, the inspections have been obviously concentrated on checking declarations, inspecting storage sites and destruc-

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

Tablica 1 – *Univerzalnost Konvencije o kemijskom oružju u odnosu na druge konvencije o oružjima za masovno uništavanje*

Treaty Ugovor	Entry into force Stupanje na snagu	SPs zemlje-članice	Other signatories Drugi potpisnici	Non-signatories Nije potpisalo
NPT Ugovor o neširenju nuklearnog oružja	1970	190	0	5
BTWC Konvencija o biološkom oružju	1975	163	13	19
CWC Konvencija o kemijskom oružju	1997	188	2	5

Table 2 – *Important data from the declarations by the SPs (as of November 30, 2009)*

Tablica 2 – *Važni podaci iz deklaracija Zemalja članica (do 30. studenog 2009.)*

Subject Predmet	Declaring SPs Deklarirano zemalja-članica	Declared sites Deklarirano lokacija
CW storage facilities Skladišta kem. oružja	7	38
CW destruction facilities Postrojenja za uništavanje kem. oružja	6	37
CW production facilities Postrojenje za proizvodnju kem. oružja	13	70*
Abandoned CW Napušteno kem. oružje	3	35
Old CW Staro kem. oružje	13	47
Chemical industry *Kemijska industrija*		
Schedule 1 chemicals Kemikalije s Popisa 1	22	27
Schedule 2 chemicals Kemikalije s Popisa 2	38	456
Schedule 3 chemicals Kemikalije s Popisa 3	35	479
Discrete organic chemicals Druge organske kemikalije	80	4579

* If it is not otherwise stated, the data are reported as of November 30, 2009.

** At the same time the nuclear weapons states recognised under the Nuclear Non-Proliferation Treaty.

* Of the 65 reported (former) CWPFs, 62 certified as already destroyed (43) or converted for peaceful purposes (19)

* Od ukupno (ranije) deklariranih 70 lokacija za proizvodnju kem. oružja, 62 su potvrđena kao već uništena (43) ili prenamijenjena u mirne svrhe (19)

tion of CW stockpiles and CW production facilities and, in the chemical industry, on facilities producing scheduled chemicals.

At present, the most important task is undoubtedly destruction of CW:

Declared chemical agents:	71,194 metric tonnes
Destroyed:	39,585 metric tonnes (i. e. 55.6 %)
Declared munitions (containers)	8.67 million items
Destroyed	3.93 million items (i. e. 45.3 %)

As expected, the destruction proceeds asymmetrically, with construction of destruction facilities meeting with domestic financial and technological difficulties and acceptance problems by local populations.

The scheduled 10 year term set by the CWC for total CW destruction has not been met, and an allowed exemption to extend the destruction period for another 5 years has already been agreed for the Russian Federation and for the US. It seems now that it will be difficult for the latter SP to meet even the extended deadline for total destruction. On the other hand, Albania and South Korea had already finished destruction of their small stockpiles in 2008, as had India in 2009.

Table 3 overviews the inspection activities. If we relate declared sites to inspection frequency, it is obvious that the main effort has been concentrated on checking declarations submitted by the SPs concerning the closed storage and production facilities, and to ongoing processes of CW destruction.

Somewhat less attention has been devoted to the industry that produces scheduled chemicals. In future, when all CW stockpiles have been destroyed, the inspection effort will be focused on industry. For the reasons explained in the chapters in this book* dealing with the impact of scientific and technological development on the Convention, it seems that potential threats stem mainly from the industry producing discrete organic chemicals. This is because of the changing face of the chemical industry and new developments in organic synthesis that are able to deliver new unscheduled toxic chemicals with incredible rapidity, something which was not expected when the Convention was drafted. That is why the inspection effort devoted to this part of industry seems to be low; it is restricted by the limited numbers of inspection personnel. The high number of such facilities worldwide (about 5600) as compared with the number of inspected facilities (up till now something over 1600, most of which have been inspected only once) clearly indicates the necessity to increase the focus on this type of site. The limited personnel capacity of inspection teams could be enhanced through two means. First, there could be considerable economising in the (till now continuous on-site) inspections at the destruction of CW stockpiles, which nowadays are regulated also by stringent domestic legislation dealing with both security and safety, namely health and workplace safety, and environmental protection. Secondly there could be increased utilisation of the capabilities of control and analytical instrumentation and other relevant information technology, including equipment for continuous checking, remote and off-site sensing, perimeter watching and observation, data recording, data transmission in real time, central data processing etc.

T a b l e 3 – *Inspection activities (as of November 30, 2009)*

T a b l i c a 3 – *Inspekcijske aktivnosti (do 30. studenog 2009.)*

Subject Predmet	Inspected sites Pregledano lokacija	Inspections* Broj inspekcija
CW production facilities Postrojenja za uništavanje kem. oružja	67	415
CW destruction facilities CW destruction facilities Postrojenja za uništavanje kem. oružja	37	1221
CW storage facilities Skladišta kem. oružja	38	413
Abandoned CW Napušteno kem. oružje	35	52
Old CW Staro kem. oružje	47	90
Industry inspections *Inspekcije u industriji*		
Schedule 1 chemicals Kemikalije s Popisa 1	36	202
Schedule 2 chemicals Kemikalije s Popisa 2	254	486
Schedule 3 chemicals Kemikalije s Popisa 3	234	277
Discrete organic chemicals Druge organske kemikalije	579	761

* 81 SPs have been inspected
* Inspekcije su obuhvatile 81 Zemlju-članicu

Organisation for the Prohibition of Chemical Weapons – OPCW

Pursuant to the CWC, after its signature, the Preparatory Commission was founded and after its entry into force, the Organisation for the Prohibition of Chemical Weapons (OPCW) was established, with its headquarters in The Hague, The Netherlands.[2]

The Organisation consists of three main elements: Conference of the States Parties, Executive Council and Technical Secretariat.

With regard to the topic of this paper, it is necessary to stress the important role of the main subsidiary body. This is the OPCW Scientific Advisory Board (SAB). Consisting of 25 independent experts (from SPs), it plays a crucial role in advising the Technical Secretariat and the Director-General on issues of scientific and technological development having actual or potential impact on the CWC and its implementa-

* See the chapters by Clagett, Perry Robinson and Trapp in this volume. See the reference at the footnote on page 1.

tion. The SAB solves important issues by utilising broader scientific expertise, organising Temporary Working Groups (TWG) and launching some projects in cooperation with, for example, the International Union of Pure and Applied Chemistry. It also takes active part in other workshops and fora organised by the OPCW, and cooperates with specific organs of the OPCW.

Main Results of Both CWC Review Conferences

The aim and tasks for the First Review Conference (2003) were determined as follows:

– Review operations of the Convention.

– Take account of scientific and technological development.

– Lessons learned and recommendation for future implementation.

It was not an amendment (revision) conference.

The attendance represented 113 (then) SPs, two signatory states (Haiti, Israel), two non-signatory states (Libya, Angola), five international organisations – the European Space Agency (ESA), ICRC, the Permanent Court of Arbitration (PCA), the Comprehensive Test Ban Treaty Organisation (CTBTO) and UNIDIR – 22 NGOs and six industry associations. Despite a somewhat provocative statement by the US alleging non-compliance by Iran and concerns about the Sudan, the Conference did not collapse into disarray and the CWC has not met the fate of BTWC.* The Conference did not result in radical change of direction for the OPCW or make 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 other problems).

However, a number of priorities were clearly recognised. These included:

– 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.
– Functioning of the OPCW.

Detailed explanation of these priorities is beyond the aim of this paper. For further information the adopted documents can be consulted. First there is the political declaration containing 23 paragraphs[3] and the main written result – the review document with 134 paragraphs.[4] Except for many mostly general statements, the programme did not go too deeply into the problems of the impact of scientific and technological development on the CWC that are obviously relevant to its future implementation. That issue was however deeply analysed in the document prepared by the OPCW Scientific Advisory Board and introduced to the Conference in the Note by the Director-General.[5]

For the present status of the CWC's implementation, the developments between the 1st and the 2nd Review Conferences were of utmost importance.

Some of recommendations of the OPCW SAB are reflected in the SAB's recent advice, and especially in projects that have been launched recently. It is generally expected that their results will influence the present and future activities of the OPCW, considering the crucial importance of the impact of scientific and technological development on the CWC, especially after current CW stockpiles have been destroyed. Recent advice and recommendations by the SAB are related to:

– Salts of scheduled chemicals (of the same toxicological importance as free bases).
– Captive use of (scheduled) chemicals (generally not important for possible misuse).
– Structure of ricin (A + B chains, connected by disulphide crosslinking).
– Role of the Chemical Abstract Service (CAS) figures (only an auxiliary tool, with no regulatory power).

The ongoing projects under the aegis of the OPCW SAB include:

– Biomedical Sampling and Analysis (in investigating alleged use of CW) (TWG).
– Sampling and Analysis to upgrade objective verification efforts (TWG).
– Education and Outreach (a joint OPCW-IUPAC project) on introducing CWC issues in university curricula and on codes of conduct of chemists and life scientists. Workshops have been held in Bologna, Oxford and Moscow in 2005, and in Bologna in 2006. The latter workshop was associated with an informal SAB meeting.[7]

For detailed information on the above-mentioned recent activities of the SAB.[6,7,8] Those reports were utilized by the Open-ended Group, established within the OPCW Technical Secretariat, in preparing the 2nd Review Conference. These preparations, marked by the 10th anniversary of the OPCW and entry into force of the CWC, also involved *inter alia*:

– A joint OPCW-IUPAC Workshop on Advances in Science and Technology (Zagreb, April, 2007).[9]
– OPCW Academic Forum (The Hague, September, 2007).[10]
– OPCW Industry and Assistance Forum (The Hague, November, 2007).[11]
– OPCW NGO Forum (The Hague, November 2007).

The Second Review Conference took place in The Hague from April 7 – 18, 2008. Its character and tasks were defined simply as "Review operations of the CWC", consistent with the requirement of the Convention for the review conferences. The attendance represented 114 SPs, two signatory states (Guinea-Bissau and Israel), three non-signatories (Angola, Iraq, Lebanon), five international organisations, and 28 NGOs.

* The last two (the 5th and 6th) BTWC Review Conferences were unable to adopt the Additional Protocol on implementation and verification that could have enhanced it to the level of the CWC with respect to, for example, declarations, verification mechanisms, destruction, non-proliferation, organization and national implementation measures. This addition (which itself was elaborated by prestigious international NGOs with the basic input of Federation of American Scientists in 1990–91) has been negotiated at four consecutive BTWC Review Conferences since the early 1990s. It was finally blocked by the US at the 6th Review Conference in 2006.

Beside general debate, procedural questions and reports of subsidiary bodies, especially that of the OPCW Scientific Advisory Board[12] dealing with problems of advances in science and technology and their impact on the Convention and its implementation, the programme went very deeply into all problems of reviewing and assessing the operations of the Convention in all its aspects, including especially:

1. The role of the CWC in enhancing international peace and security and in achieving the objectives as set forth in the preamble of the CWC.

2. Ensuring the universality of the CWC.

3. Implementation of the CWC's provisions, related to:

(a) General obligations and declarations related thereto.

(b) Destruction of CW and destruction/conversion of CWPFs.

(c) Verification activities of the OPCW.

(d) Activities not prohibited by the CWC.

(e) National implementation measures.

(f) Consultations, cooperation, and fact-finding.

(g) Assistance and protection against CW.

(h) Economic and technological development.

(i) Articles XII to XV of the CWC and final clauses.

(j) The protection of confidential information.

4. The general functioning of the OPCW.

The Second Review Conference, being very well prepared, and utilising results of a series of activities carried out within the framework of, and celebrating the 10th anniversary of, the CWC's entry into force in 2007 (as described above), analysed individual points in a very deep and comprehensive manner. This is clearly reflected in one central document, adopted at the end of the conference[13] that will orient activities in chemical disarmament for the following five years. Detailed analysis of this document is beyond the aim of this paper.

Present Role of Engineers and Scientists in Implementing the Convention

Engineers and scientists and their organisations made major contributions to negotiating and drafting the CWC and to its difficult ratification process, thereby enabling its entry into force. They again are now playing an important role in its implementation.

The complicated and extensive text of the CWC body and annexes, many of them connected with implementation and verification, need precise study, explanation and acceptance by all segments of society committed to act pursuant to its provisions. The experience with implementing the CWC through national legislative systems has shown how difficult it is for initially less well-informed people to understand its provisions, however committed they may be to taking part in the implementation of those provisions. The first approach of, for example, those in industry with legal obligations under the treaty, was their frequently expressed thesis: What do we have to do with prohibition of any weapons – that is purely a military issue? It was and still is necessary to do much work in education and outreach on national as well as international levels, starting with educating officials of national authorities and the preparation of national implementation measures with respect to their legal and technical aspects.

The practice of implementation, especially in countries possessing CW (and in countries where old CW are found), deals at present with very dangerous operations of CW destruction and disposal. The CWC leaves full responsibility in the choice of effective technology to the SPs but does not allow such environmentally barbaric methods of destruction/disposal, routinely used still in the 1970s, such as sea dumping, earth burial, open-pit burning or blasting. Development of cost-effective and safe technologies for the whole process of destruction (starting from storage sites up to the disposal of metal scrap and non toxic end-products) under domestic legal workplace safety and environmental standards are amongst the important international cooperative tasks of the scientific and technological communities.

Development of verification technologies utilising the most sophisticated instrumental analytical techniques for detection, identification and determination of trace amounts or concentrations of toxic chemicals, their metabolites, breakdown products and excess impurities in other industrial chemicals, or under environmental conditions and in biological samples, is another serious task necessary for verifying implementation of all provisions of the CWC.

Assistance and Protection are also amongst the main pillars of the CWC. These terms imply providing both equipment and know-how in detection and monitoring, decontamination, protection of personnel and medical treatments to those SPs that are experienced in this domain, and also to SPs with less or even zero experience with armed forces and the protection of the population. This area is gaining increased importance, not only because of possible military use of CW by non-SPs but also because of the increasing peacetime threats that modern industrialised society poses, including possible chemical, biological, radiological and nuclear terrorist attacks.

Impact of Scientific and Technological Development on the Convention and the Future Role of Engineers and Scientists

Both Review Conferences, and especially the reports prepared by the OPCW Scientific Advisory Board, identified positive and negative aspects of the impact of scientific and technological development on the CWC and its implementation.

Consistent with these views it is possible to formulate the role of engineers and scientists and their organisations in the future implementation of the CWC. In the first instance there is their engagement in finishing the complete and safe destruction of CW stockpiles, and the destruction or conversion of the CWPFs. Then there is their involvement in assuring the non-proliferation of CW, i. e. verifying non-production by the peaceful chemical industry of potential CW, taking into account threats and benefits posed by scientific and technological development.

Potential threats arise from scientific and technological developments because of the accelerated pace of production of new toxic chemicals, from new synthetic methods and from the changing face of the chemical industry.

One present threat lies already in the inconsistency of the CWC with regard to riot-control agents. Even though law enforcement and domestic riot control are explicitly mentioned among the purposes not prohibited, the particular CWC wording (Article I, paragraph 5) prohibiting use of riot-control agents as a method of warfare is generally understood as *ipso facto* exempting these agents from the definition of toxic chemicals (for the purposes of the CWC); this has consequences for the current verification regime – even these known agents are unscheduled. This is a significant loophole in the CWC, allowing its possible circumvention because R&D and production of such chemicals are outside routine verification regimes. One can imagine legitimate search for new effective and safe (how safe?) irritants and various kinds of incapacitants based on a wide spectrum of toxicological action (calmatives, algogens, various bioregulators either isolated or of synthetic origin, influencing some biogenic processes associated with the nervous system) for policing purposes, but there are also temptations in the direction of the uncontrolled development and production of means that sometime might be used on battlefields.

This problem of so-called non-lethal agents is a real, current and very serious problem. Every toxicologist knows that the toxic effect on, or response of, an organism is dose- (exposure-) dependent. This means that so-called non-lethal agents do not exist at all. The safety index of irritants and other harassing agents depends on the difference between the statistically determined dose (involving both concentration and exposure time) that has intolerable effects and the dose that causes death. This index of safety should be as big as possible, but it cannot by its very nature be unlimited. That is why the concept of 'non-lethality' is inevitably imprecise.

Future threats arise mainly from the changing face of synthetic and manufacturing methods for production of both scheduled and new (unscheduled) toxic compounds. These new threats come primarily from the rapid pace of development in bio-molecular science (e.g. genomics and proteomics) and in chemical synthesis (i. e. combinatorial chemistry) that can produce toxic chemicals for potential misuse. These methods enable the very rapid syntheses of extensive series of compounds with 'tailored' structures, the effects of which are predicted theoretically on the basis of molecular engineering or architecture. Thus, what took months or years to produce in the classical era of organic synthesis in the middle of the 20th century can today be achieved within days or weeks.

We are now faced also with the changed character of the chemical industry. Many parts of the chemical industry operate with multipurpose batch facilities whose production can readily be switched from one product to another. The potential of producing toxic chemicals is also considerably enhanced by the use of microreactors producing large volumes in small plants. Globalisation of this industry therefore necessitates reviewing the verification regime of 'other chemical production facilities' producing discrete organic chemicals. The number of such facilities (see Table 2) that are currently almost without international supervision shows the importance of this issue.

The ever-growing range of toxic chemicals and new processes of small-scale syntheses increase also the threat of chemical terrorism.

The main benefits of scientific and technological development can be expected in the development of progressive analytical methods and relevant high technology instrumentation. Many modern separation techniques (such as gas chromatography and high performance liquid chromatography) coupled with identification techniques (such as mass spectrometry) and other spectrophotometric methods (such as Fourier transform infra-red spectroscopy), and linked with computerised data-libraries accessible on-line, have been introduced into the OPCW-designated laboratories; some of these techniques are used routinely in portable or mobile equipment for on-site inspections. The problems are to keep up with the rapid development of potential (mainly unscheduled) toxic chemicals, technical upgrading of equipment, analysis of toxins and biological samples, conservation and transportation of samples for off-site analysis and the like. It is also desirable to introduce utilisation of automated analytical techniques. This includes remote (off-site) methods with automatic data transmission in real time to reduce the burden of continuous on-site presence of inspectors verifying destruction of CW. Verification efforts also need to shift to counter the much greater future threat by ensuring the non-production of CW by the increasing and spreading peaceful chemical industry facilities that manufacture discrete organic chemicals (see the bottom line of Table 2). The multifaceted technical issue of verification and its many practical applications is beyond the scope of this article, but it can be concluded that, if the power of modern analytical science were to be used to its full extent, all analytical requirements of the CWC could be achieved.

Another very significant contribution of scientific and technological development that should be widely utilised in future implementation of Article X (relating to Assistance and Protection), includes the delivery of means and of know-how in the continuously developing areas of:

– Detection, identification and monitoring (point and stand-off detection, i. e. simple means, automatic alarms, reconnaissance vehicles, stand-off sensors, data transmission, field-portable and mobile laboratories and sets).

– Decontamination (means and methods for decontamination of personnel, decontamination of equipment and materiel, decontamination of stationary objects, decontamination and treatment of water).

– Protection of personnel (protective masks, suits, accessories and other means for armies, civil and population protection, for general and specialist use, shelters, filtration, ventilation and special equipment, filter-ventilated combat and transport vehicles.

– Treatment of intoxication (first aid methods and means, such as antidotes, syringes, auto injectors and other equipment, medical treatment methods and means, therapeutic procedures, equipment, evacuation and rescue systems, rescue and evacuation vehicles).

Other challenges of scientific and technological development are associated with the work of the OPCW, its Technical Secretariat and with education and outreach. Those issues also should be matters of interest to concerned engineers and scientists and their organisations.

Conclusions

The international community of engineers and scientists, including individual experts directly engaged in the negotiations as well as professional organisations, institutions and NGOs of concerned scientists, has played a positive role from the early stages of negotiations on the CW ban, through advanced negotiations of the CWC, preparations for its entry into force and during the first period of implementing the CWC.[14]

Operations of the Chemical Weapons Convention that most probably would not exist without valuable input of expertise by the scientific and technological communities are proceeding generally satisfactorily,* judged according to the status of its implementation by the 188 States Parties and through verification by the Organisation for Prohibition of the Chemical Weapons in The Hague. The First Review Conference stressed the importance of achieving worldwide universality in order to totally eliminate the dark legacy of past chemical arsenals once and forever, to prevent threats and to utilise the benefits of scientific and technological development for the implementation of the CWC in the foreseeable future. These positive trends were confirmed by the outcome of the Second Review Conference in 2008. The future implementation of the CWC involves an essential active role for scientific and technological expertise, including the engagement of NGOs of concerned engineers and scientists.

* Except for the delayed schedule of destruction by the main CW possessors.

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SAŽETAK

Konvencija o zabrani kemijskoj oružja i uloga inženjera i znanstvenika

J. Matoušek

Kemijsko oružje, kao i cijela vojna tehnologija, povezana je s aktivnostima inženjera i znanstvenika. Međutim, kemijsko oružje se razlikuje u odnosu na druge vojne tehnologije po tome, što je ono nastalo i prvi puta masovno upotrijebljeno izravnim sudjelovanjem znamenitih kemičara. Opisan je znatan doprinos inženjera i znanstvenika te njihovih organizacija pregovorima o kemijskom razoružanju, uključujući i stvaranje (pisanje) Konvencije o zabrani kemijskog oružja. Razmatra se njihova sadašnja i buduća uloga u provedbi Konvencije uzimajući u obzir ugroze i dobrobit koje donose napredak znanosti i tehnologije, naglašavajući neovisnu ekspertizu Znanstvenog savjeta Organizacije za zabranu kemijskog oružja.

Masaryk University Faculty of Science
EU Research Centre of Excellence for Environmental Chemistry and Ecotoxicology
Brno, Czech Republic

Prispjelo 8. siječnja 2009.
Prihvaćeno 4. studenog 2009.