Chemical Weapons and International Cooperation[1]

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An international treaty that took effect in 1997 outlaws weapons that work through the toxic properties of chemicals in man or other animals. Scientific progress is changing the technologies that can foster these weapons, and the world, too, is changing. How well can that treaty – the 1993 Chemical Weapons Convention – be expected to survive both political and technical change?

To explain what is at stake, I shall show you four images that I will discuss in turn. The first is an aerial photograph taken nearly 90 years ago of a battlefield in Flanders. The second is a recent view of the Indian city of Bhopal, where thousands of people died after chemicals escaped from a factory in December 1984. The third is a street scene in the Iraqi town of Halabja just after government forces had attacked it with chemical weapons in March 1988. The final image is a press photograph of Russian soldiers in October 2002 carrying bodies out of a Moscow theatre where antiterrorist chemical weapons had been used to free an audience taken hostage.

Many chemicals have aggressive properties that can used for weapons purposes -- explosive chemicals and propellants, most obviously, but also incendiaries, flame agents, obscurants, radio-active substances and others. Those used in so-called 'chemical weapons' are exploited primarily for their toxicity, which is to say their ability to cause death, temporary incapacitation or permanent harm through chemical action on life processes.

Toxic chemicals, including those popularly thought of as 'poisons', have been used as weapons since ancient times, just as they have been for murder, and judicial killing. Something radically new happened on 22 April 1915 at Ypres, in Belgium, during the First World War. Chlorine gas – familiar today from public swimming-pools and the like -- became the world's first "weapon of mass destruction". The first of my four images shows how.

[1] Item 446 Rev.1, 11 January 2005. This is an updated and documented version of a presentation made during the Public Discussion Meeting, *Elimination of Weapons of Mass Destruction*, that the British Pugwash Group sponsored on 8 September 2004 during the British Association *2004 Festival of Science*, University of Exeter.

Courtesy US National Archives. *Gas and flame attack.* SC 10879 EU - MIB

German forces had laboriously emplaced some six thousand cylinders of compressed chlorine gas along seven kilometres of front-line trenches opposite the French position on the Ypres salient, between the villages of Bikshote and Langemark. Outlets of the cylinders in groups of ten were linked through a manifold to an emission hose. When the direction and strength of the wind finally became favourable, the hundreds of stopcocks were opened to release a great volume of heavy asphyxiating vapour into what was a gentle late-afternoon breeze. The 'poison gas' rolled unstoppably into the French trenches where it seems that everyone who could do so fled to escape it, the majority (according to some accounts) unsuccessfully. A similar attack next day hit the adjacent Canadian sector. Five thousand people are said to have been killed by the chlorine and another 15,000 wounded. It was the future Nobel laureate Fritz Haber who had conceived and promoted the idea of cloud-gas weapons as a means for invading the protection that trenches afforded against conventional attack. He had been stimulated by the great physical chemist Walther Nernst, who had long been thinking about possible chemical solutions to the trench problem (his chief idea was tear gas spread from artillery shell).

The German chlorine onslaught ruptured the Allied defence lines, but German forces had made no preparations to exploit their achievement, and the trench warfare returned to its largely static condition. There was retaliation in kind, of course, and then a continuing struggle for chemical supremacy over the next three and half years, which consumed enormous tonnages of poison and afflicted more than a million people. Except to make two general observations, I shall not go any further into this. There is a large literature about it all – of which the latest publication is one of the very best, the paper by William van der Kloot in the May 2004 issue of the Royal Society's *Notes and Records.* It has a properly descriptive

title: "April 1915: Five future Nobel prize-winners inaugurate Weapons of Mass Destruction and the academic-industrial-military complex".

The first observation I want to make is that it was not from military arsenals or even from military science that that novel and potentially war-winning weapon -- massively discharged cloud gas -- originated, but from civil industry. The new weapon exploited a particular German industrial advantage: capacity for large-scale liquefaction of chlorine gas, a bedrock chemical in a sector of manufacturing industry in which Germany was then pre-eminent. This was the first major manifestation of the circumstance we nowadays call "dual use": a technology that has both a peaceful side and a weapons side. It is here that the "international cooperation" of my title chiefly comes in: the procedures agreed among nations 88 years later for assuring one another that their dual-use chemical industry was not being abused in covert preparation for chemical warfare. That is where the primary value of the 1993 Chemical Weapons Convention resided and continues to reside.

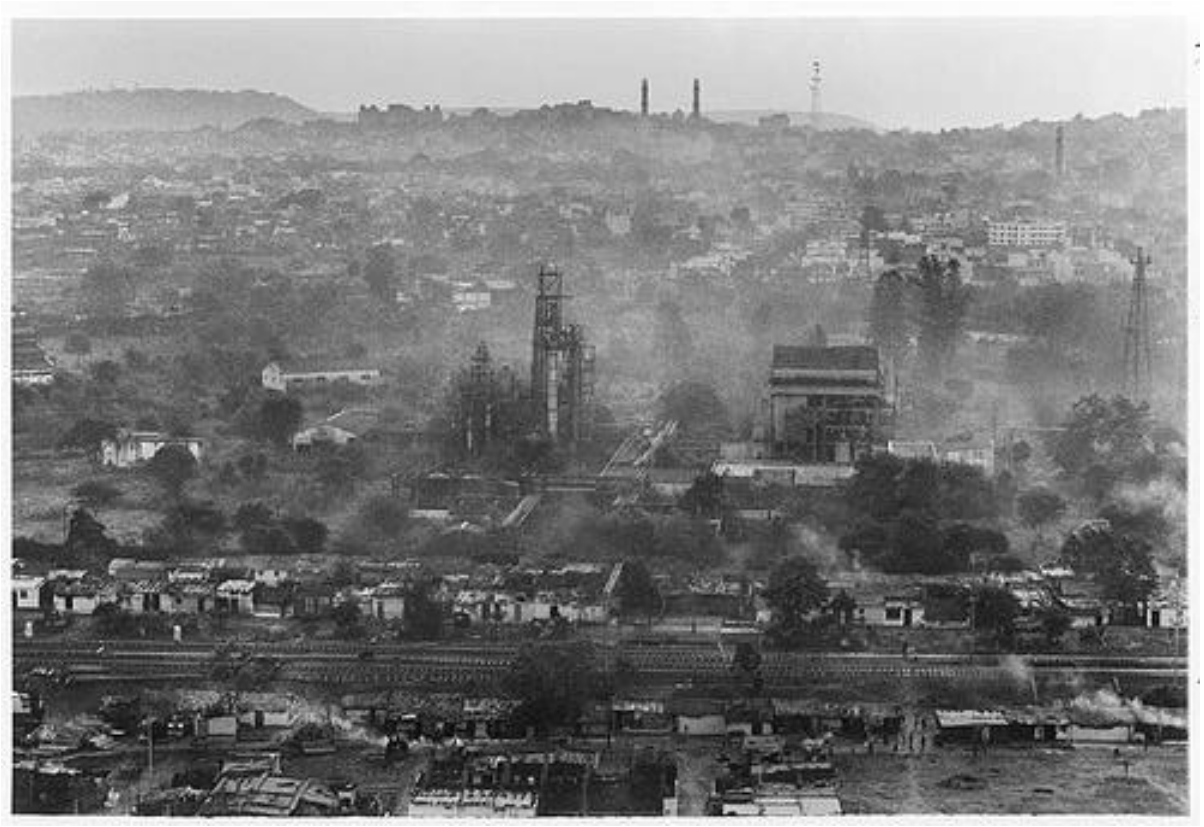
My second observation has to do with what it actually was that made those gas-cylinders into a weapon of mass destruction (WMD). It was environmental mediation. Uniquely among the weapons systems of the time, ambient air was a key component of the system. Through massive air pollution, it conferred the effectiveness over wide areas that enabled mass killing in a short period of time.

Yet that same feature also facilitated protection against the new weapon. A simple filter interposed between individuals and the air they breathed – the "gas mask" or respirator – could in principle negate the mass-destructiveness of the weapon; likewise, later, a shield of protective clothing interposed between the skin and droplets of skin-acting liquid poison, such as mustard gas or some other blister agent. Maybe 'negate' is too strong a word. For disciplined, trained and well-equipped soldiery, perhaps; but for civilian populations, no, though some small rich countries have gone on attempting it. Anyway, as the Great War ground on and as nations subsequently built upon its experience, a novel form of technological arms race set in: weapons vs protection, and vice versa. Protection tends to win, as Table 1 below shows.

Where did that ascendancy of protection leave the military usefulness of chemical weapons? On the battlefield their utility became dominated by the state of the other side's protective measures. If there are no gas masks, no protective clothing, the weapons remain WMD. But if there is good protection, that property may be lost. This is perhaps why, since the First World War, chemical warfare has happened only in the Third World, where good protection has rarely been available. This is shown in Table 2 below.

Yet even in the high-tech environment of the Cold War, protection was not thought to have rendered chemical weapons useless in war between industrially advanced belligerents. On the contrary: protection provided a *raison d'être*. Chemical weapons could force enemy troops into the encumbrance of protective posture – clumsy gas masks, hot NBC suits, thick gloves -- degrading their combat performance. Marginal comparative advantage on the battlefield could, it was believed during the nuclear-armed confrontation in Europe, tip the balance.

Thus the notion of like-with-like chemical-warfare deterrence, which arose at the strategic level during the Second World War perhaps thereby keeping chemical weapons off most of the battlefields of that war, perpetuated itself thereafter at the tactical level. Huge quantities of second and third generation nerve gases (see Table 1) were accumulated for battlefield scenarios, which, if acted out in Europe according to the war plans, would have left soldiers relatively unharmed but not the downwind non-combatants, who, unprotected, might have died in their millions. By which time nuclear warfare would surely have begun, rendering the nerve gas utterly otiose.



Greenpeace/Raghu Rai. *Photoessay: Remembering Bhopal*, no. 19, "A view of the abandoned Union Carbide pesticide plant". http://www.outlookindia.com

For my second image I move away from Europe to Asia, not to Indochina (where, in the forms of tear gas and herbicides, chemical weapons were massively used during the Vietnam War of 1961-75[2]) but to India. The image is of the city of Bhopal, the site of a terrible chemical-industry catastrophe during the night of 2-3 December 1984.

The photograph was taken quite recently and shows, not a sparsely populated plain as in that image of World War I mass destruction, but a densely populated urban area. The building in the middle, abutting hundreds of modest dwellings, is a now-abandoned chemical factory that had been built to make the pesticide carbaryl, or, as the factory-owners Union Carbide called it, Sevin. This was done by a process involving methyl isocyanate (MIC), which is an industrial intermediate of substantial toxicity (by civil if not military standards) and high vapour tension. For reasons that are still not entirely clear, a large storage tank vented tens of tons of MIC into the soft breeze over a night-time city under meteorological conditions that favoured accumulation of high airborne dosages of the poison at ground level. Four thousand people were soon dead from their exposure, and 50 times that number were injured. Of those 203,000 people injured, more than 20,000 were permanently harmed, and another 10,000 have died a premature death.

There is a large literature on this calamity,[3] so I shall not go into it any further, but I want to make two general observations. The first is that the number of lethal doses of MIC

[2] Estimates of the total quantity of chemical herbicides and of Agent CS used by US forces during the Vietnam War derived from incomplete official data are set out in J P Perry Robinson, "Chemical and biological warfare developments: 1985", *SIPRI Chemical & Biological Warfare Studies* no 6, 1986, at pp 53-55.

[3] See, especially: Edvard Karlsson, Nils Karlsson, Gösta Lindberg, Björn Lindgren and Stellan Winter, "The Bhopal catastrophe – consequences of a liquefied gas discharge", *FOA report* [Sweden: National Defence Research Institute] C40212-C1, February 1985; J M Dave, "The Bhopal methyl isocyanate (MIC) incident: an overview", in H B Schiefer (editor), *Highly Toxic Chemicals: Detection and Protection Methods. Proceedings of*

mobilized and made airborne during that terrible event was probably about the same as the number of lethal doses of nerve gas that can be set loose from the warhead of a single Scud missile. The Bhopal event therefore reminded the world of the vulnerability of cities towards chemical weapons. It lent awful substance to the idea of nerve gas as a poor man's nuclear weapon.

Secondly, that comparative estimate also illustrates how immensely aggressive specially developed chemical-warfare agents are as compared with toxic chemicals found in civil industry. This divergence grew wider as the Cold War advanced and, with it, the emergence of still more aggressive chemicals. The key development criterion was that a given expenditure of chemical munitions – shells, bombs, rocket warheads &c filled with toxic chemicals and suitable dissemination devices – should be competitive in lethal effectiveness with the same expenditure of conventional munitions, which were themselves becoming deadlier as their development continued. If there were no such comparative advantage, there would be no military point in incurring the odium of illegal resort to chemical warfare, and, as a deterrent, the weapons would lack credibility.

Yet, like the chlorine cylinders of Ypres, the Bhopal catastrophe showed that terrible harm could be caused by civil chemicals, if circumstances favoured it. Hence our concern today about chemical terrorists, who may be able to access toxic industrial chemicals (known as TICs in the antiterrorism business) where they could not access nerve gas. And not only terrorists: TICs may have a utility in the New Wars[4] that chemical weapons lacked in the old.[5] In the Old Wars, the utility of chemical weapons was set by their competitiveness with conventional weapons – by their aggressivity, not by their simple accessibility and capacity to terrorize, features which were surely what stimulated the use of TICs as weapons in the Bosnia war, for example, and in Chechnya.[6]

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a Symposium Saskatoon, Canada: University of Saskatchewan Toxicology Research Centre, 1985, pp 1-37; B Bowonder, "Industrial hazard management: an analysis of the Bhopal accident", *Project Appraisal* vol 2 no 3 (September 1987) pp 157-68; Wil Lepkowski, *Chemical & Engineering News* vol 72 no 51 (19 Dec 1994), pp 8-18, "Bhopal ten years later"; Amnesty International, *Clouds of Injustice: Bhopal Disaster 20 Years On*, London: Amnesty International Publications, 2004 [AI index ASA 20/015/2004], 98 pp.

[4] Mary Kaldor, *New & Old Wars: Organized Violence in a Global Era*, Cambridge: Polity, 1999.

[5] J P Perry Robinson, "The General Purpose Criterion and the new utility of toxicants as weapons", a paper presented at the 15th workshop of the Pugwash Study Group on Implementation of the CBW Conventions, Oegstgeest, the Netherlands, 23-24 June 2001

[6] For an unrivalled published review of the reported use of TICs and suchlike non-military toxic chemicals as weapons, see Theodore Karasik, *Toxic Warfare*, RAND Corporation, MR1572, 2002, at pp 17-28, Chapter Three, "Recent use of and thinking about toxic weapons".

"Victims of the chemical attack on Halabja", by Ahmad Banakashani, in *A Photo Report on the Chemical Massacre in Halabja by Iranian Photographers*, Iran Photo Foundation, May 1988, p.27.

My third image dates from March 1988 and shows the actuality of what the Bhopal catastrophe portended, anti-civilian chemical warfare on a large scale. The photograph was taken outside a dwelling in Halabja, in the Kurdish part of Iraq. The Baghdad regime has just bombed the town, its own citizens, with nerve gas and mustard gas. The nerve gas has killed so quickly that these people seem asleep. According to one authoritative account,[7] "About 5000 – 7000 of the total population of 80,000 died as immediate casualties of the attack, and a further 30,000 – 40,000 of the population were injured, many severely". In fact this was not the first time a civilian population had been targeted with chemical weapons. The Iranian border town of Sardasht had suffered that fate, on a lesser scale, nearly a year previously,[8] though the politics of the Iraq-Iran War meant that we in this country hardly heard about it. Perhaps for political reasons also, an investigation of the Sardasht episode by a UN inspection team apparently remained unpublished.[9] And Kurdish villages, hundreds of them, fell victim to continuing Iraqi state chemical terrorism during 1987-88.

The chemical warfare during that first Gulf War changed many of our preconceptions, not least about the proliferation of chemical weapons. When Iraq started using mustard and nerve gas against Iranian troops in 1983, we in the West tended to suppose that the USSR had supplied them. So it was a nasty shock to discover that in fact Iraq had made the chemicals itself out of intermediates (precursors) purchased mainly from private industry in the West

[7] Christine Gosden, Mike Amitay, Derek Gardener and Bakhtiar Amin, "Examining long-term severe health consequences of CBW use against civilian populations", *Disarmament Forum* [Geneva: UNIDIR] 1999 no 3 (August 1999) pp 67-71.

[8] Harvard Sussex Program, *CBW Events Data-Base*, record for 870628-29.

[9] Letter dated 10 August 1987 from the Permanent Representative of the Islamic Republic of Iran to the United Nations addressed to the Secretary-General, distributed via UN doc A/42/467-S/19029 of 10 Aug 87.

and in India. Iraq also bought in plant from the West.[10] The 'dual use' problem was thus becoming transformed, and countries in North Africa and the Middle East were said to be queuing up to learn how Iraq had done it. Proliferation of the weapons was well and truly under way, no longer confined to the NATO and Soviet blocs plus – maybe -- just a few special friends. This endangered the interests of many states, particularly the rich industrialized countries, who hastily formed what became known as the Australia Group. Its participants undertook to control exports of listed chemical precursors and, later, of listed items of production equipment.[11]

The Iraq events also gave a huge boost to the multilateral arms-control talks on chemical weapons that had been proceeding in Geneva since conclusion of the 1972 Biological Weapons Convention. With complete global chemical disarmament as the arms-control objective, these talks were addressing chemical weapons from the demand side as well as from the supply side that was concerning the Australia Group. International cooperation through the rules and procedures of a treaty regime was seen as the best way of coping with dual use. I shall describe something of the course of these talks, which culminated in the 1993 Chemical Weapons Convention (the CWC), before showing my final image.

International law, mainly in the form of the 1925 Geneva Protocol, already prohibited resort to chemical warfare. Now the aim was to outlaw the means of chemical warfare as well as its use. This could be done effectively only by the imposition of controls on chemical industry worldwide that would suppress abuse of dual-use potential with as little impact as possible on normal peaceful activities. From the mid-1980s onwards, the industry itself was pushing for diplomatic action, no doubt embarrassed by the revelations about Iraq.

By 1992 a text was agreed.[12] It was opened for signature the following year. Then began what proved to be a four-year task of building the international organization known as the OPCW – Organization for the Prohibition of Chemical Weapons -- that would oversee implementation of the treaty, including operation of its international verification system in collaboration with the National Authorities of the states parties. This mammoth task was achieved under the leadership of a British chemical engineer turned diplomat, Ian Kenyon. It is something in which we can take pride.

The OPCW is headquartered in The Hague and has 500 international civil servants in its Technical Secretariat, 200 trained inspectors among them. By the end of 2004, the OPCW had 167 member states and, of the other 27 or so countries in the world that could join, 16 had signed the CWC but not yet ratified it. International take-up has thus been impressive, even though there are still important holdouts in the Middle East and on the other side of Asia.

The CWC requires its states parties to declare their holdings of chemical weapons and factories for making them so that the OPCW can then check their destruction or elimination. There have been some surprises, as Table 3 below shows. Few people expected as many as

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[10] A major new addition to the published literature on this topic is the final report of the Iraq Survey Group, recently published by the US Central Intelligence Agency: *Comprehensive Report of the Special Advisor to the DCI on Iraq's WMD*, 30 September 2004. It is the final volume of this thousand-page report that addresses chemical (and biological) weapons.

[11] For a detailed account of the early days of the Australia Group, see J P Perry Robinson, "The Australia Group and the Chemical Weapons Convention", a paper presented at the 19th Workshop of the Pugwash CBW Study Group, Geneva, 11-12 January 1992. An earlier version is published as "The Australia Group: a description and assessment" in Hans Günter Brauch, H J van der Graaf, John Grin and Wim Smit (editors), *Controlling Military Research & Development and Exports of Dual Use Technologies as a Problem of Disarmament and Arms Control Policy in the 1990s*, Amsterdam: VU University Press, and New York: St Martin's Press, 1992, pp 157-176. For information about the Australia Group today, see its website at <www.australiagroup.net>.

[12] For an account of how this happened, see J P Perry Robinson, "The negotiations on the Chemical Weapons Convention: an historical overview", in M Bothe, N Ronzitti and A Rosas (editors) *The New Chemical Weapons Convention – Implementation and Prospects*, Kluwer Law International, 1998, pp 17-32.

13 of the states parties to declare chemical-weapons capability. Of the chemical weapons declared, seven toxic chemicals constitute more than 95 percent of the total tonnage. All are blister or nerve agents. They are identified in Table 4 below.

It is instructive to note that the most heavily stockpiled chemical-weapon agent is also the newest, a Soviet nerve gas commonly known as R-33 or VR whose chemical identity the Soviet Union sought to conceal throughout the treaty negotiation. The OPCW Technical Secretariat for some reason calls it VX, which is the symbol used by NATO for one of the US nerve gases.

Included in Table 4 are figures on the total tonnage of each agent declared. To set into perspective such quantitative data, which are important for an adequate understanding of the problem of chemical weapons today, Table 5 collects together a variety of reference points.

Notice, in Table 4, that even the newest of the chemical weapons entered production twenty years before the CWC was signed. Does that mean that toxicants discovered since then lie outside the treaty and can therefore be used to evade it? No! Chemical weapons, in the meaning of the CWC, are defined to include *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*: beautiful, prescient language setting out the so-called 'general purpose criterion' that copes at once not only with the 'dual use' problem but also with the problem of still-secret or as-yet-undiscovered chemical-warfare agents.

Have there been any such discoveries? Yes. Table 1 above has an entry for "fourth generation" nerve gases – the so-called Novichoks. And novel substances that combine high toxicity with low lethality are actually being weaponized, the CWC notwithstanding.

These last include chemicals that serve the interests of those who are pushing into public expenditure, for police or military service, the concept of 'non lethal' weapons technology, and they bring me to the last of my four images.

"Theatre of War: Russian special forces end the hostage crisis. Carried out by rescuers hostages were dazed from the gas." *Time* magazine, vol 160 no 19 (4 November 2002).

This is late October 2002 outside a theatre in Moscow. A musical had been playing there two days previously when its audience of some 800 people were taken hostage by armed Chechen

activists. The 50 hostage-takers included women with explosives strapped around them, ready to be detonated upon command. The photograph shows bodies – "dazed hostages" according to its caption in *Time* magazine -- being carried out from the theatre after just such a 'non lethal' weapon had been used to liberate them. There were more than 170 deaths, including most, perhaps all, of the hostage-takers, who had been shot dead.

I do not want here to explore the issues involved or get much further into the details of what happened – save to ask this: Which way should the episode best be described:

- Non-lethal chemical weapon regrettably kills 129 of the 850 people exposed to it? Or,
- New chemical weapon triumphantly saves 671 of 800 people in mortal danger from terrorists?

The chemical agent used by the Russian security forces that stormed the theatre was an opioid formulation based on fentanyl and disseminated as aerosol. It is a further illustration of dual use, for those chemicals have widespread use as surgical anaesthetics.

Our government in the United Kingdom made no public demur at the use of opioids to lift the Moscow theatre siege. On the contrary, the government seemed to condone it – hardly surprising, one may think, as it has itself been actively studying the possibilities of such 'non lethal' chemical weapons for decades. In the United States, the Army Chemical Corps first began examining fentanyl as a possible weapon in 1963.[13] Goodness knows what the Americans have come up with since then. They seem to have gotten somewhere, given the advocacy that can now be heard from across the Atlantic for amendment of the Chemical Weapons Convention so as to liberate high-toxicity/low-lethality chemicals from its strictures.[14]

The point of this final part of my presentation has not been to mock or otherwise denigrate non-lethal weapons technology. It is instead to warn that the proper functioning of the OPCW is currently endangered

- not only by the possibly irrepressible propensity of 'dual use' to make at least some chemical weapons accessible;
- not only by new utilities for chemical weapons now emerging from the changing nature of warfare;
- not only by the proliferation of chemical-warfare technology to those we choose to call 'rogue states';
- but also by the emergence of a new attraction of chemical weapons to those very same rogue-callers – us – in the concept of antiterrorist chemical weapons.

Accordingly my conclusion is that the valuable international cooperation against chemical weapons established by the CWC and embodied in the OPCW is now under threat from four quite different directions.

[13] See the entry for 630515 in J P Perry Robinson, "Disabling chemical weapons: a documented chronology of events, 1945-2003", 1 November 2003 (unpublished).

[14] Described in J P Perry Robinson, "Solving the problem of 'law enforcement'", a paper presented at the 19th Workshop of the Pugwash Study Group on Implementation of the CBW Conventions, *The First CWC Review Conference and Beyond*, Oegstgeest, the Netherlands, 26-27 April 2003.

Table 1. Weapons vs protection

Novel weapon	***Example of weapon***	***Induced countermeasure***
Asphyxiating vapour	Chlorine	Thiosulphite-impregnated hoods
Toxic vapour not absorbed by thiosulphite	Phosgene	Hexamethylenetetramine-impregnated hoods
Much heavier concentrations of current agents	Larger munitions, or TOT artillery fire	Respirators with activated-charcoal filters
Toxic vapour not readily adsorbed on charcoal	Hydrogen cyanide, cyanogen chloride, perfluoroisobutene	Impregnants added to respirator charcoal
Toxic particulate aerosol	Diphenylchloroarsine	Particulate filter added to respirator
Skin-burning liquid spray	Mustard gas, lewisite	Protective clothing as well as respirators
Agents toxic at smaller, even imperceptible, airborne dosages	1st and 2nd generation nerve gas: tabun, sarin	Mask on warning; automatic field detectors; antidote-autoinjectors
Supertoxic percutaneous agent	3rd generation nerve gas: VX, VR	Better protective clothing
Toxic (per)cutaneous agent adsorbed onto fine dust Supertoxic IVA (intermediate volatility agent)	Dusty mustard &c Soman	Even better protective clothing and respirators; prophylactic drugs
Agents not detectable by existing alarms or otherwise able to evade some standard countermeasures	4th generation nerve gas: Novichoks	Better detectors, decontaminants and antidotes

Table 2. Authenticated instances of battlefield or terrorist use of toxic antipersonnel chemicals since World War I

Period	***Location of use***	**Toxic chemical used**	***[trivial name]***
1919	North Russia	bis(2-chloroethyl) sulphide 10-chloro-5,10-dihydrophenarsazine diphenylchloroarsine	Mustard gas Adamsite, or DM Clark I, or DA
1923-26	Morocco	bis(2-chloroethyl) sulphide bromomethyl ethyl ketone trichloronitromethane	Mustard gas Bn-Stoff Chloropicrin
1935-40	Abyssinia	bis(2-chloroethyl) sulphide carbonyl dichloride chlorine 1-chloroacetophenone diphenylchloroarsine phenyldichloroarsine	Mustard gas Phosgene Chlorine CN Clark I, or DA PD
1937-45	Manchuria	bis(2-chloroethyl) sulphide carbonyl dichloride 1-chloroacetophenone 2-chlorovinyldichloroarsine diphenylcyanoarsine hydrogen cyanide	Mustard gas Phosgene CN Lewisite Clark II, or DC AC
1963-67	Yemen	bis(2-chloroethyl) sulphide carbonyl dichloride 1-chloroacetophenone	Mustard gas Phosgene CN
1965-75	Vietnam	2-chlorobenzalmalononitrile	CS
1983-88	Iran/Iraq	bis(2-chloroethyl) sulphide 2-chlorobenzalmalononitrile ethyl N,N-dimethylphosphoramidocyanidate O-cyclohexyl methylphosphonofluoridate O-isopropyl methylphosphonofluoridate	Mustard gas CS Tabun, or GA Cyclosarin, or GF Sarin, or GB
1994-95	Japan	O-isopropyl methylphosphonofluoridate	Sarin, or GB

Source: World Health Organization, *Public Health Response to Biological and Chemical Weapons*, Geneva: WHO, 2004, p 35.

Table 3. Countries that have declared post-1945 chemical-weapons capability to the OPCW

[a] Countries that have declared to the OPCW factories where chemical weapons had been made after 1 January 1946

Bosnia & Hercegovina
China
France
*India
Iran
Japan
*Libya
*Russia
Serbia & Montenegro
*South Korea
United Kingdom
*United States of America

*also declared possession of chemical weapons

[b] And one country that declared possession of chemical weapons but no factories

Albania

Table 4. Toxic chemicals declared as chemical weapons to the OPCW

Of the total tonnage declared, these chemicals comprised more than 95 percent		***Year of initial industrial-scale production***	***Declared holdings*** (metric tons, rounded)
chemical name	*trivial name*		
O-isobutyl S-2-diethylaminoethyl methylphosphonothiolate	VR (R33)	1972, in USSR	15,600
O-isopropyl methylphosphonofluoridate	Sarin (R35, GB)	1952, in USA	15,000
bis(2-chloroethyl) sulphide	Mustard (R74, H)	1917, in Germany	13,900
O-pinacolyl methylphosphonofluoridate	Soman (R55, GD)	1967, in USSR	9,200
2-chlorovinyldichloroarsine	Lewisite (R43, L)	1918, in USA	6,800
O-ethyl S-2-diisopropylaminoethyl methylphosphonothiolate	VX	1961, in USA	4,000
bis(2-chloroethylthioethyl) ether, 40 percent (rest mustard)	Runcol (HT)	1938, in UK	3,500

Note: Chemical weapons, in the sense of the 1993 Chemical Weapons Convention, include all "***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***" [CWC Art II.1].

Table 5. Tons of toxic chemical: significance indicators

Metric tons of toxic chemical –		***Total***	***UK only***		
Used as weapons in World War 1		120,000	14,000		
Stockpiled in World War 2		400,000	55,000		
Stockpiled at onset of Cold War		325,000	62,000		
Declared as chemical weapons by states parties to the CWC, 1997 on, now being destroyed		71,400	0	Russia USA India South Korea Albania Libya	40,000 27,800 *x* 2100 - *x* 16 24*
Stockpiled as chemical weapons today by states not parties to the CWC		???	--	Egypt Iraq Israel North Korea Syria	?? 0 ?? ?? ??
Released at Ypres, 22-23 April 1915 (chlorine)		150	-		
Used as weapons by USA during Vietnam War, 1961-75	Herbicides CS gas	82,000 7,800	--		
Used as weapons by Iraq during its war with Iran, 1981-88		>2,540			
Destroyed in Iraq under UNSCOM supervision, 1991-98		800*			
Discharged over Bhopal, 2-3 Dec 1984 (methyl isocyanate)		30	-		
Needed for effective attack on a 50-200 hectare battlefield target	HCN Mustard VX CS Sarin	50 7 4 2 1	-		

* Plus some thousands of tons of precursors

** The final report of the Iraq Survey Group states that Iraq declared that it had consumed 1800 tons of mustard gas during the war, 140 tons of tabun and over 600 tons of sarin. The report presents no information on the substantial quantity of CS gas also used as a chemical weapon.