

# IUPAC, OPCW, and the Chemical Weapons Convention



by Leiv K. Sydnes

**IUPAC's ultimate goal is to serve humankind through chemistry. This is done in a number of ways that are not apparent to most people outside the Union. An important and visible service is the work done by IUPAC for the Organisation for the Prohibition of Chemical Weapons (OPCW).**

The first formal contact between IUPAC and OPCW dates back to 2001. As part of OPCW's preparation for the First Review Conference of the Chemical Weapons Convention (CWC),<sup>1</sup> IUPAC received an invitation to produce a report evaluating the scientific and technological advances that had taken place in the chemical sciences since the convention entered into force in 1993. The reason for this request was that the Convention requires a review of the CWC every five years in recognition of the evolutionary nature of the agreement.

Within the treaty, there is an instrument that makes it possible to adjust and modify the Convention as deemed necessary, and the objective of the Review Conferences is to look into just that and recommend changes on the basis of a review of the implementation of the CWC and evaluation of relevant scientific and technological developments. Such advances may relate to the scope of the prohibitions set out in the CWC, they may affect the way the Convention is being implemented, or they may create opportunities for advancing international cooperation among States Parties<sup>2</sup> in areas such as protection against chemical weapons and the productive application of chemistry. Dialog between the OPCW and the scientific community in evaluating scientific and technological progress also creates opportunities to advance awareness of the CWC and its requirements in the scientific, technological, and industrial communities where the need for more knowledge about the Convention is apparent.

The decision to include IUPAC as a partner in the preparation of the conference was indeed a natural consequence of the fact that IUPAC was (and still is) the only independent, nongovernmental, international organization devoted to chemistry and the chemical sciences and their application in research, industry,

and society. After a meeting between the OPCW leadership and an IUPAC delegation chaired by the then President Alan Hayes at the OPCW headquarters in The Hague, The Netherlands, there was no doubt that IUPAC should accept the offer with appreciation and start to do the work.

After thorough discussions, it was decided first to hold an international workshop with participants from all parts of the world and prepare a draft report, and then appoint a small team of authors to finalize the document. Following this plan, an international group of some 75 specialists from around 35 countries, covering the relevant fields of the chemical sciences, accepted the invitation to become involved in the work. During a workshop held in Bergen, Norway, in July 2002, the main parts of the report were drafted, and through subsequent electronic communication, the report was finalized. The document was widely distributed within OPCW, published in *Pure and Applied Chemistry (PAC)* as a technical report,<sup>3</sup> and finally presented at the Open Forum during the First Review Conference in May of 2003.<sup>4</sup>

Five years later, in April 2007, the process was repeated. This time Zagreb, Croatia, was the workshop venue. The meeting was organized and run following the same format as in Bergen since it had proved to work well. Participants came from all parts of the world, and like the first time, the final report was published in *PAC*.<sup>5</sup>

In 2011, the same process was repeated again, and IUPAC was asked to take the lead in the preparation of the report on chemistry and chemical technology required for the Third Review Conference scheduled for April 2013. Once more, IUPAC accepted the invitation with pleasure.

## The 2012 Spiez Meeting

This time, the international workshop, run again using the same format as in Bergen, was held in February 2012 in Spiez, Switzerland, in the facilities of Spiez Laboratory, a Swiss defense establishment dealing with protection from nuclear, biological, and chemical threats. IUPAC assembled an international advisory committee and a program committee for the meeting; the latter consulted with the OPCW Technical Secretariat but had been given primary responsibility for the organization of the workshop. The workshop

consisted of eight topical plenary sessions, which focused on the following specific topics:

- Overview and Background
- Convergence of Chemistry and Biology
- New Synthesis and Toxicological Analysis Methods
- Developing New Materials and Delivery Mechanisms
- Advances in Industrial Production Methods
- Chemical Safety and Security: Possession, Transfer, and Acquisition
- Defense against Chemical Weapons Agents
- Chemical Safety and Security: Engaging the Chemical Community

In addition, there was one session dealing with technical discussions about new developments in technology and anticipated technological challenges.

In each plenary session, two or three speakers discussed the state of the art, presented current challenges, and predicted future developments within a given field or topic related to a category of advancement in the chemical sciences and chemical technology. After the presentations, there was time set aside for comments, discussions, and elaborations. Breakout sessions provided opportunities to further consider the information presented, and a facilitated, concluding discussion made it possible to look at issues in a larger perspective and draw conclusions based on extrapolations of trends and developments in recent years.

Conclusions were reached on a number of specific issues of importance in a chemical-weapons context, which was a significant development. However, just as important for the future standing and regulatory strength of the CWC is the assessment of how current trends in a number of scientific and technological disciplines are believed to have impact on the CWC. A report was published in *PAC*<sup>6</sup> in April 2013, just in advance of the Third Review Conference.\* An understanding of the present situation is, therefore, important to “guesstimate” what the future holds; the following pages outline current trends and observations.

\* Concurrent with the *PAC* article, Sydes’ commentary “Update the Chemical Weapons Convention,” was published 4 April 2013 in *Nature* 496, 25–26; <http://dx.doi.org/10.1038/496025a>.

## Pace and Nature of Advances

A major factor to consider is the pace of changes and advances in science and technology, which has quickened in recent years. In particular, a number of innovations in the medical and biological sciences, such as inexpensive and rapid DNA sequencing and synthesis, are driving advances forward very rapidly. Many of these innovations are chemistry based, and this is helping to expand chemistry to scientific disciplines where the knowledge of chemistry is limited and the consequences of dual use of chemicals is not acknowledged. In the long run, this might become an issue.

It is clear that the developments in the fields of science and technology continue to be evolutionary for the CWC rather than being disruptive with game-changing consequences. In the 10 years since the first workshop, such developments have not had a dramatic impact on how chemical weapons can be produced and used. It was noted that any application of new technologies to the production of traditional chemical weapons would depend on consideration

of many factors, the outcome of which would depend on the country concerned. Many of the technologies discussed at the workshop may not yet be available to all developing countries or to all potential proliferators. The availability of crude chemical mixtures, containing chemicals that are highly toxic, remains a concern.

It was also acknowledged that advances in science and technology have numerous positive uses and are likely to be much more beneficial than harmful. The CWC seeks to strike an appropriate balance between preventing the use of toxic chemicals as weapons while not impeding the application of science and technology for beneficial purposes; achieving this balance will continue to be important in the future. As the pace of technological advances continues, the OPCW’s role in providing developing countries with opportunities to receive equipment and training will continue to be important.

## Continued Progress in Science and Technology

Science and technology continue to progress steadily in most areas of relevance to the CWC. Synthesis and production of chemicals may be improved through the use of flow microreactors, which provide safety



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advantages for certain types of (exothermic) reactions or for reactions that involve toxic chemicals and by-products. However, significant research is required to optimize chemical processes in microreactor systems, and although the use of microreactors has become more and more widespread in recent years, dramatic advances have not been observed. It therefore remains unclear whether use of microreactors will have significant implications for the production of chemical weapons on a large scale.

Chemicals may also be produced through bio-mediated processes, an area that highlights increasing convergence between chemistry and other scientific disciplines, including biology. Developments in synthetic biology are also relevant to this trend. Toxins and bioregulatory molecules exemplify chemicals that are prohibited by both the Biological Weapons Convention<sup>7</sup> and Chemical Weapons Convention. As a result, the communities associated with both Conventions will need to continue considering how best to monitor relevant developments and address potential implications.

include encapsulation in nano- or micro-scale carriers, improved targeting and uptake in biological tissues, and improved ability to deliver large molecular-weight molecules across biological barriers. The same techniques can potentially be employed for more effective delivery of toxic chemicals, although it was also emphasized during the workshop discussions that there is no evidence of this having taken place so far.

Analytical tools and opportunities exist to increase the technical convenience and applicability as part of the development of next generation analysis and detection systems. In particular, systems that are simple and robust to use and that combine multiple types of analysis would be extremely useful. Although such devices are not currently available, and the detection of toxins remains less reliable, participants suggested that it is only a matter of time before the technology meets necessary portability, robustness, and selectivity requirements. Miniaturization is also a key focus for future developments in field detection.

In the area of countermeasures, several continuing gaps were noted in the capacity to respond to incidents involving chemical weapons. Further research on absorbents for decontamination purposes will likely be needed, and strategies such as regional support systems to help provide capacity for the effective medical treatment of chemical weapon victims may be useful.

The ethical, legal, and operational concerns surrounding riot-control agents and incapacitating chemical agents<sup>9</sup> will also continue to be a topic considered by the OPCW. It remains a matter of consideration whether policy solutions such as new chemical schedules in the CWC or the creation of international norms surrounding the use of these types of chemicals will be needed in the context of the CWC.

### Changing Context of the CWC

The gradually changing context of the CWC cannot be ignored. States Parties have traditionally been concerned with chemical weapons on a massive scale, and the Chemical Schedules<sup>10</sup> and inspection regimes mainly focus on certain types and larger quantities of chemicals. However, it is quite conceivable that changes in production technology may make other types of chemicals and facilities more relevant in the not-too-distant future. Furthermore, scenarios involving the production of chemical weapons on a small scale by activists and terrorists are definitely different from those associated with large state-sponsored programs. These differences extend beyond the chemical agents and delivery systems and encompass signifi-



*Boutros Boutros-Ghali, Secretary-General of the United Nations, at the presiding table of the United Nations Educational, Scientific and Cultural Organization (UNESCO) Headquarters in Paris, for the signing of Chemical Weapons Treaty. (1993)*

Delivery technology in medicine is another field in which steady advances have occurred, driven largely by the development of improved medicines or chemotherapeutic agents. These advances

cantly different requirements when it comes to effective detection and monitoring.

A central aspect in this context is knowledge of synthetic chemistry and easy access to such competence. For example, scientific literature can now be accessed much more easily using search engines and readily available information technology. As advances continue to be made, a trend toward the democratization of science and technology is likely, and may have implications for the ongoing monitoring of relevant scientific progress and potential implications. There is also the fundamental issue of serendipity in scientific advances to keep in mind. As a result, it will continue to be important to consider how such events can be dealt with at the technological and institutional level.

## Education, Outreach, and Partnerships

Finally, the 2012 Spiez workshop discussions emphasized the roles that may be played by many communities in promoting chemical safety and security. Education, outreach, and awareness-raising will be vital all over the world, and issues related to chemical weapons may be effectively embedded within a broader context of risk and messages about the responsible acquisition, use, and disposal of chemicals. It is therefore wise to promote, preach, and teach chemical safety and security in conjunction with other initiatives such as Responsible Care<sup>9</sup> and the Green Customs initiative.<sup>10</sup> The value of regional approaches should not be underestimated and national authorities dealing with CW issues, civil-society organizations, and scientific groups such as IUPAC and national chemical societies will clearly have complementary roles to play.

The need for increased awareness about chemicals in relation to chemical weapons in general and CWC in particular is also necessary among practicing chemists. Unfortunately, it is a fact that in most countries these topics are not even mentioned in the regular courses given at almost all universities. A welcome and very appropriate initiative, would be to develop relevant course material to cover these topics. Since the material needed for such an undertaking has to have a global perspective, the task is demanding and calls for contributions from focused task groups with international composition. This is a *modus operandi* which fits the IUPAC project system perfectly, and I am quite confident that IUPAC is looking forward to becoming involved in the generation and execution of relevant projects in this and related fields.

## Code of Conduct

A way to increase the awareness in the chemical community could be to have each chemist draft a Code of Conduct adopted to each working situation and experiences. Within IUPAC, the idea of developing such a document has been aired, but until a few years back, the conclusion was always that the task was too difficult to handle well. The argument was that the dual use of many chemicals made it impossible to find the short, precise wording required in such an important document. Of course, the potential misuse would have to be properly described and spelled out, but the problem is that the same chemical principles and many of the same chemicals that are involved in abuse, misuse, and misconduct, contribute to the application of chemistry in the service of humankind when applied in a proper fashion. As a result, nothing happened for a long time.

What triggered a change was an initiative of the then OPCW Director-General, Ambassador Pfirter, who in a letter to the OPCW Scientific Advisory Board noted that “OPCW needs to clearly establish what it requires in the field of education, outreach, and international cooperation [... and these] activities would benefit from increased cooperation with other international, regional, and national organizations.” This led to a joint OPCW/IUPAC workshop in Oxford, England, in July 2005 (see [www.iupac.org/project/2004-048-1-020](http://www.iupac.org/project/2004-048-1-020)) in which a range of topics were discussed: How to increase the awareness of the CWC in the scientific community, facilitate the integration of issues related to the Convention into chemistry teaching, and promote professional conduct of chemists and chemical engineers. Fruitful sessions and lively discussions generated significant ideas; one idea that was picked up swiftly was the push for a code of conduct.<sup>11</sup>

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The need to develop a code of conduct for chemists was not a new idea in IUPAC. A group under the leadership of Graham S. Pearson from the UK had in fact started to discuss just that before the Oxford meeting took place, but the acknowledgement of the need was further strengthened when several chemical-weapons issues, such as the general purpose criterion and the dual use of chemicals, were taken

into consideration. From an IUPAC point of view it was important to carry out the work as an inclusive process, which meant involving the whole organization and engaging the member countries before a proposal, in due course, could be presented. Such a process was carried through by Pearson's task group, and the resulting document was sent to the IUPAC Executive Committee, which decided not to move forward toward a formal recommendation, but to document the process and the discussion in an article in *Chemistry International*.<sup>12</sup> When studied carefully, it is clear that the basis for a Code of Conduct for chemists is in place. Is anyone ready to join such a cause?

## Final Remarks

As chemists, we are fully aware of the blessings of our science, but almost on a daily basis we are reminded through news media about the problems chemicals may cause when used without proper consideration. However, we are probably never exposed to the dark side of chemistry more clearly than when we face the consequences of the use of chemical weapons. It is argued, correctly in my opinion, that chemistry cannot be blamed for chemical warfare, but since chemical reactions work even in the hands of those without knowledge of chemistry, the chemical community has the duty to be aware of the potential danger and act to prevent all misuse and abuse of chemicals. Collectively, the chemical community is not yet well prepared to do this job, but a good start would be to reflect on the trends and potential problems outlined in this piece and then act to improve the situation. 

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## References

1. (a) Organisation for the Prohibition of Chemical Weapons, <www.opcw.org>; (b) Chemical Weapons Convention, full text available at <www.opcw.org/chemical-weapons-convention/>; (c) Annex on Chemicals <www.opcw.org/chemical-weapons-convention/annex-on-chemicals/a-guidelines-for-schedules-of-chemicals/>.
2. In this context a State Party is a term used for a country/state that is a member of OPCW.
3. (a) G.W. Parshall, et al, *Pure Appl. Chem.*, 2002, Vol. 74, No. 12, pp. 2323-2352; (b) Lectures presented at the Bergen workshop are published in *Pure Appl. Chem.*, 2002, Vol. 74, No. 12, pp. 2229-2322; [www.iupac.org/publications/pac/conferences/Bergen\\_2002-06-30p/](http://www.iupac.org/publications/pac/conferences/Bergen_2002-06-30p/)
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6. K. Smallwood, R. Trapp, R. Mathews, B. Schmidt and L.K. Sydnes, *Pure Appl. Chem.*, 2013, Vol. 85, No. 4, pp. 851-881; <http://dx.doi.org/10.1351/PAC-REP-12-11-18>
7. The Biological Weapons Convention can be downloaded from The Biological and Toxin Weapons website at [www.opbw.org](http://www.opbw.org).
8. Incapacitating chemical agents (ICA) are chemical compounds or mixtures of chemical compounds that are able to incapacitate human beings for some time. The topic is regularly dealt with at expert meetings like the ICRC Expert Meeting in Montreux, 24-26 March 2010. The report from the conference can be downloaded from [www.icrc.org/eng/assets/files/publication/ICRC-002-045](http://www.icrc.org/eng/assets/files/publication/ICRC-002-045).
9. Responsible Care is a global initiative that works a) to improve the health, safety and environmental (HSE) performance in the chemical industry and b) to maintain an open and transparent communication with stakeholders. The initiative was launched in 1985 by the Canadian Chemical Producers' Association. For information, see for instance [www.canadianchemistry.ca/ResponsibleCareHome.aspx](http://www.canadianchemistry.ca/ResponsibleCareHome.aspx).
10. Green Customs is an international initiative that is working to prevent illegal trade of environmentally-sensitive commodities. For information, go to its homepage at [www.greencustoms.org](http://www.greencustoms.org).
11. G.S. Pearson and P. Mahaffy, *Pure Appl. Chem.*, 2006, Vol. 78, No. 11, pp. 2169-2192; <http://dx.doi.org/10.1351/pac200678112169>
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IUPAC project 2005-029-1-050 delivered a reliable, online resource to raise awareness about the **Multiple Uses of Chemicals and the Chemical Weapons Convention**—free online @ [www.iupac.org/multiple-uses-of-chemicals](http://www.iupac.org/multiple-uses-of-chemicals)

