OPCW

Scientific Advisory Board

Thirty-Eighth Session
27 – 31 May 2024

SAB-38/1
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REPORT OF THE SCIENTIFIC ADVISORY BOARD AT ITS THIRTY-EIGHTH SESSION

1. AGENDA ITEM ONE – Opening of the session

1.1 The Scientific Advisory Board (SAB) met for its Thirty-Eighth Session from 27 to 31 May 2024. The session was chaired by Mr Günter Povoden, with Prof Imee Su Martinez serving as Vice-Chairperson.

1.2 Mr Povoden opened the Thirty-Eighth Session of the SAB by welcoming all Board members and especially the five newly elected members who joined the Board in January 2024. He recalled that the role of the SAB is to enable the Director-General in the performance of his functions, and to render specialised advice to the Conference of the States Parties, the Executive Council (the Council), or States Parties in areas of science and technology relevant to the Chemical Weapons Convention (the Convention). Mr Povoden emphasised that the advice of the SAB is objective, impartial, and free from political influence. He further recalled that the role and functions of the Board are set out in its terms of reference and that the Board has a code of conduct that all members adhere to in the execution of their duties, in order to act in the best interests of the scientific advisory process. Mr Povoden noted that the SAB is responsible for assessing developments in scientific and technological fields relevant to the Convention, such as artificial intelligence (AI) and other emerging technologies, and it plays an important role in ensuring that the OPCW adapts effectively to the evolving scientific landscape. In closing, the Chairperson thanked the four Board members who will leave the SAB at the end of 2024.

Executive summary

1.3 The Board met in person at the OPCW Main Building and those members unable to travel were able to participate virtually via the Organisation's video conferencing equipment.

1.4 The SAB received seven briefings from external speakers on topics including persistent nerve agents; chemical, biological, radiological, nuclear (CBRN) defence innovation; machine learning; unmanned aerial vehicles (UAVs); metal-organic frameworks (MOFs); and laboratory automation. The Board also heard from staff members of the Technical Secretariat (the Secretariat), and received updates from the Secretaries to the SAB, the Advisory Board on Education and Outreach (ABEO), and the Open-Ended Working Group on Terrorism (OEWG-T), and from the OPCW Laboratory, the Inspectorate Division, and the International Cooperation and Assistance Division (ICA). An update on the activities of the OPCW Centre for Chemistry and Technology (ChemTech Centre) was also provided by the Office of Strategy and Policy. The

Chairperson of the recently established Temporary Working Group (TWG) on Chemical Forensics updated the Board on the mandate of the Group and its progress to date. Several Board members also presented their own research and provided updates on recent activities of interest to the SAB. The SAB dedicated sessions to discussing the impact of AI and other emerging technologies, and to considering its approach to the Sixth Review Conference.[1]

1.5 Based on deliberations at its Thirty-Eighth Session, the Board recommends to the Director-General through this report that:

(a) the Secretariat continue to utilise the diverse, relevant experience and expertise of SAB members in its ongoing activities. Many SAB members have taken part in ICA events over the years and remain very willing to assist in the important work of the Division. Likewise, SAB members may provide useful technical support for exercises and other activities at the ChemTech Centre;

(b) a TWG on the impact of AI and related technologies relevant to the Convention be established. The Board has observed that AI is increasingly impacting the chemical sciences and many other disciplines and technologies. By extension, its maturation will impact the Convention and the work of the OPCW. Given the rapid pace of AI development and its likely far-reaching influence, the Board further recommends that the terms of reference be carefully developed, ideally through a scoping workshop, such that the TWG can focus on specific questions of relevance to maximise the utility of its ultimate advice and recommendations;

(c) the following topics for future TWGs continue to be considered:

(i) scientific and technical considerations regarding chemicals acting on the central nervous system (CNS);[2] and

(ii) long-term degradation and effects of abandoned and old chemical weapons and associated chemicals;[3]

(d) the Secretariat consider employing, or otherwise having available, for example, through a short-term secondment, experts on specific areas of technology related to the Convention, such as in AI and synthetic biology; and

(e) to facilitate the exchange of information on the chemicals that were added to the Annex on Chemicals to the Convention in 2019, a topical workshop be held. This recommendation reiterates the advice provided by the Board in its report to the Fifth Review Conference.[4]

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1 Review Conference = Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention.

2 Previously recommended in paragraph 31 of RC-5/DG.1 (dated 22 February 2023).

3 SAB-37/1, dated 1 September 2023.

4 Paragraph 27 of RC-5/DG.1.

2. AGENDA ITEM TWO – Adoption of the agenda

The SAB adopted the following agenda for its Thirty-Eighth Session:

1. Opening of the session
2. Adoption of the agenda
3. Welcome address by H.E. Ambassador Fernando Arias
4. *Tour de table*
5. Establishment of a drafting committee
6. Update on the activities of the Technical Secretariat and the SAB
7. Update on the SAB Temporary Working Group on Chemical Forensics
8. Update on the activities of the Open-Ended Working Group on Terrorism
9. Update on the activities of the Advisory Board on Education and Outreach
10. Update on activities at the OPCW Centre for Chemistry and Technology
11. Overview of international cooperation, assistance, and protection programmes
12. Inspectorate Division in 2024: The way forward
13. CBRN defence innovation in the Austrian armed forces
14. Persistent nerve agents
15. Upcoming workshop on deployable equipment
16. OPCW Laboratory at the Centre for Chemistry and Technology: One year onward
17. Chemical markers for chlorine release in environmental samples
18. Machine learning for rapid detection of novel chemical weapons
19. Overview of spray unmanned aerial vehicles in agriculture
20. Solving big problems with small things
21. Navigating the VX nerve agent incident at Kuala Lumpur International Airport 2, Malaysia: Lessons learned, best practices, and the challenges ahead
22. From batch to flow: Advancing synthetic organic chemistry through technological innovation
23. Synthesis of useful and harmful chemicals in the age of computers
24. SAB discussion on the impact of AI and other emerging technologies
25. SAB discussion on its approach to the Sixth Review Conference

26. Update from SAB members on conferences and publications

27. SAB Chairperson and Vice-Chairperson election

28. Any other business and closing remarks

29. Adoption of the report

30. Closure of the session

3. AGENDA ITEM THREE – Welcome address by H.E. Ambassador Fernando Arias

3.1 The Director-General welcomed the attendees to the Thirty-Eighth Session of the SAB and offered a particular acknowledgment to the five new members joining the Board. Echoing the Chairperson's opening remarks, he stressed the ongoing and critical importance of the Board's work in providing objective, high-level, and apolitical scientific advice to ensure effective decision-making.

3.2 The Director-General described how the threat spectrum is expanding, facilitated by the rapid developments in science and technology, and noted that there is an increased risk of misuse of non-traditional agents, such as biotoxins and CNS-acting chemicals. He underscored the importance of ensuring that the OPCW remains capable of deriving as much information as possible from any available samples from an investigated incident. Chemical forensics plays a pivotal role in this regard, and the newly established TWG on Chemical Forensics will ensure that the OPCW harnesses the utility of chemical forensics approaches effectively and is able to use validated results in any investigation of misuse of a chemical. The TWG will review the science and technology relevant to chemical forensics and identify remaining gaps and challenges.

3.3 As the ChemTech Centre is now fully operational, the Director-General briefly updated the Board on ongoing and forthcoming projects and training courses being undertaken there. Work at the ChemTech Centre is critical for strengthening the capabilities of Member States and the OPCW in the detection and analysis of chemicals relevant to the Convention, and the Director-General highlighted the current projects on the analysis of biotoxins and on chemical forensics in this regard.

3.4 In terms of the agenda for the current session, the Director-General highlighted several topics for consideration and discussion, including ensuring the health and safety of staff on missions, and emerging technologies such as drones, additive manufacturing, and synthetic biology. He underscored the importance of AI and its rapid development, and the Board's essential role in monitoring and mitigating associated risks, as well as identifying potential benefits. The Director-General briefed the SAB on the "AI Event" he recently hosted at the OPCW, which brought together experts to review the risks and opportunities AI poses to the Convention and the OPCW. He noted that the Secretariat had recently issued a Note (S/2289/2024, dated 23 May 2024), which explains the rationale behind the AI Event, important takeaways, and the path forward for the Secretariat.

3.5 In closing his welcome address, the Director-General expressed his sincere gratitude for the valuable contributions of Board members throughout the year, including their participation in capacity-building workshops and proficiency tests.

4. AGENDA ITEM FOUR – *Tour de table*

All participants in the session were invited to introduce themselves to their colleagues. A list of participants appears in the Annex to this report.

5. AGENDA ITEM FIVE – Establishment of a drafting committee

The Chairperson asked volunteers who wished to be part of the drafting committee to prepare the report of the SAB at its Thirty-Eighth Session to notify the Chairperson, Vice-Chairperson, or Secretary.

6. AGENDA ITEM SIX – Update on the activities of the Technical Secretariat and the SAB

6.1 The Secretary to the SAB gave an overview of relevant activities from the intersessional period and provided some important reminders for this session. He began by providing a brief overview of the OPCW's next research challenge, which will focus on how AI can be used to benefit the Convention and the work of the OPCW. This "AI Challenge" will be open to research teams from all Member States, and up to EUR 65,000 will be awarded to each of four teams. The teams will have 12 months to complete their research and share their results with the Secretariat. The AI Challenge is funded by voluntary contributions from the European Union and the United Kingdom of Great Britain and Northern Ireland. Further information on the AI Challenge will be available on the OPCW public website in the coming weeks, and proposals from all States Parties are strongly encouraged.

6.2 There have been, and will be, a number of pertinent and interesting scientific conferences in 2024. The Secretary provided an overview of some of these,[5] highlighting themes of interest, as well as Board members who have been involved in them. The SAB Secretary also noted recent scientific publications of Board members.[6] In addition, he highlighted a recent publication by Secretariat staff on the importance of scientific advisory mechanisms in disarmament organisations, using the SAB as a positive example.[7]

6.3 Lastly, the SAB Secretary highlighted the importance of the reports by the SAB on science and technology in support of the OPCW Review Conferences that are held every five years. He summarised the approach and process the Board took to prepare

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5 International Conference CBRNE Research & Innovation in Strasbourg, France, from 19 to 21 March 2024 (https://cbrneconference.fr/); Non-Conventional Threat Conference (NCT) Europe 2024 in Zagreb, Croatia, from 20 to 24 May 2024 (https://nct-events.com/nct-europe); 9th EuChemS Chemistry Congress in Dublin, Ireland, from 7 to 11 July 2024 (https://euchems2024.org/); and 27th IUPAC International Conference on Chemistry Education in Pattaya, Thailand from 15 to 19 July 2024 (https://www.icce2024thailand.com/).

6 Jéssica Fonsaca, Leandro Hostert, Aldo Zarbin, and Elisa Orth. 2024. "Chemical Safety Using Functionalized Carbon Nanomaterials: Neutralization and Detection of Organophosphorus Compounds." Journal of Materials Chemistry A, 12 (14): 8124–48. doi:10.1039/d3ta07332g; Mohammadreza Parak, Alireza Asgari, Yazdan Hasani Nourian, and Mostafa Ghanei. 2024. "A Review of Poisoning with Various Types of Biotoxins and Its Common Clinical Symptoms." Toxicon 240: 107629. doi:10.1016/j.toxicon.2024.107629; and Matteo Guidotti, Andrea Leisewitz, and Massimo Ranghieri. 2023. "The endless war: the long-term impact on health and environment of armed conflicts." Annales. Proceedings of the Academy of Sciences of Bologna. Class of Physical Sciences. doi.org/10.30682/annalesps2301h.

7 Sarah Clapham and Peter Hotchkiss. 2024. "Robust scientific advisory mechanisms future-proof disarmament treaties." Nature Reviews Chemistry 8(4): 231-233. doi:10.1038/s41570-024-00594-2. PMID: 38514834.

its report to the Fifth Review Conference in 2023, and invited Board members to think about what changes to the approach may be appropriate for the Sixth Review Conference. He noted that time would be made available for an in-depth discussion on the last day of the session.

7. AGENDA ITEM SEVEN – Update on the SAB Temporary Working Group on Chemical Forensics

7.1 Dr Anne Bossée, Chairperson of the TWG on Chemical Forensics, updated the SAB on the mandate and composition of the TWG, its four principal focus areas, the agreed approach, and the work carried out by the four subgroups to date.

7.2 The objective of the TWG is to review the science and technology relevant to chemical forensics and identify remaining gaps and challenges. This will ensure that the OPCW can make best use of the information chemical forensics can yield, thus contributing to the identification of the origin of the chemical. The work of this TWG will build on the findings of the TWG on Investigative Science and Technology (SAB/REP/1/19, dated 1 December 2019), in addition to leveraging ongoing work in this area within the Secretariat. At the end of the two-year mandate of the Group, its findings and recommendations will be considered by the SAB and the Director-General.

7.3 The terms of reference[8] for the TWG on Chemical Forensics set out specific questions relating to four subtopics to be addressed by the Group, namely: the state of the art of the field; future capabilities; methods and procedures; and augmenting the capabilities of the OPCW. The Group has divided into four subgroups, according to the areas of expertise and interests of the members, to consider these subtopics.

7.4 Dr Bossée briefed the SAB on the outputs of the first meeting of the TWG, which took place virtually, on 25 and 26 March 2024. Further details can be found in SAB-38/WP.1 (dated 15 May 2024). She concluded that the discussions have been very productive and that the TWG members are particularly engaged. The second meeting of the TWG will take place from 3 to 5 June 2024.

7.5 In the ensuing question-and-answer session, the effects of decontaminating the incident site on a collected sample were discussed. It was acknowledged that decontamination would likely affect the sample. This had been explored to a limited extent in the work on the sarin precursor methylphosphonic dichloride (DC) published by Fraga et al.,[9] and the importance of developing a capability to identify degradation products was emphasised. It was agreed that biomedical data provides critical data in sample analysis, which complements the environmental sample data. The potential addition of biomedical information for chemical forensics purposes by data fusion with material environmental analysis needs to be studied. Finally, Board members discussed the standardisation of procedures and the availability of additional documentation to develop existing procedures.

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8 Annex 1 to SAB-38/WP.1 (dated 15 May 2024).

9 Carlos Fraga, Gabriel Pérez Acosta, Michael Crenshaw, Krys Wallace, Gary Mong, and Heather Colburn. 2011. “Impurity Profiling to Match a Nerve Agent to Its Precursor Source for Chemical Forensics Applications.” Analytical Chemistry 83(24): 9564-9572. doi:10.1021/ac202340u.

8. AGENDA ITEM EIGHT – Update on the activities of the Open-Ended Working Group on Terrorism

8.1 Mr Cormac O'Reilly, Senior Policy Officer and Secretary to the OEWG-T, provided an update on the Working Group. Established by the Council in 2001, the OEWG-T serves as the primary platform for States Parties to discuss challenges and exchange views on countering chemical terrorism.

8.2 The presentation particularly focused on the OEWG-T's table-top exercise held on 20 and 21 November 2023 at the ChemTech Centre, which aimed to identify and address gaps in current approaches to chemical terrorism. The exercise involved 48 participants from 24 States Parties, drawn from a range of sectors including law enforcement, public health, emergency management, and the scientific community.

8.3 The exercise featured a scenario simulating a chemical attack in a fictional country, and unfolded in three phases: pre-attack, response, and investigation. Each phase involved discussions of issues such as best practices, inter-agency coordination, and international support mechanisms. The need for continuous efforts to keep pace with scientific and technological advancements was also highlighted. In response to the exercise, participants recommended, among other things, more regular exchanges with the SAB and its members. This and other recommendations will form the basis of an action plan to be presented by the OEWG-T Chairperson at the forthcoming meeting of the Working Group.

8.4 Following the presentation, the SAB Chairperson suggested that it could be useful to red-team emerging technologies in order to explore their limitations and potential. While there are no immediate plans to do this, Mr O'Reilly agreed that there could be value in the methodology. Regarding the capabilities of States Parties to combat chemical terrorism, he clarified that it is not the intention of the OEWG-T to assess the capabilities of individual States Parties, but rather to assist them in carrying out their own assessments and that the OEWG-T will have a facilitating role in this. The Board also noted that educational materials related to chemical terrorism response at all levels are crucial for States Parties, and these need to be tailored to their specific audience in order to maximise their effectiveness.

9. AGENDA ITEM NINE – Update on the activities of the Advisory Board on Education and Outreach

9.1 Ms Luisa Sánchez-Bravo, Secretary to the ABEO, shared an update on the mandate and composition of the Board, its recent activities, and current priority areas of focus. She noted that a series of online educational resources, the so-called "e-learning modules", are now live and may be accessed on the new OPCW learning management system.[10] Following the destruction of all declared chemical weapons and the rapidly evolving current international context, Ms Sánchez-Bravo indicated that the strategic plan of the ABEO is being updated to align education and outreach priorities with the strategic priorities of the Organisation. She further remarked that the Board is compiling an inventory of academic institutions with courses on the Convention or the OPCW, including contributions from SAB members. Furthermore, the ABEO is drafting a

[10] Three introductory modules to the OPCW and its mission may be accessed at: https://learn.opcw.org.

"blue book" for the ChemTech Centre, which is a curated compilation of relevant experts and institutions that could support programmes there, or further promote the Centre. This strategic repository of contacts will facilitate and strengthen key networks and collaborations, as well as outreach efforts. Ms Sánchez-Bravo highlighted the new opportunities that the ChemTech Centre offers for educational activities and programmes, among others.

9.2 In her conclusions, Ms Sánchez-Bravo commented that education and outreach play a key role in preventing the re-emergence of chemical weapons, and that National Authorities are critical to both youth and female engagement. She added that developing partnerships with relevant international organisations and academia will amplify the visibility of the work of the OPCW and project its relevance. They will concomitantly engage the next generation in the non-proliferation and disarmament architecture through the development of a culture where chemistry is only used for peaceful purposes.

9.3 The SAB members noted the ABEO's continued efforts in developing and providing educational materials to academia, and they wondered whether similar efforts may be directed at small and medium-sized chemical enterprises, particularly in helping them better understand the rules of compliance under the Convention. Ms Sánchez-Bravo stated that the ABEO would be happy to contribute to additional educational resources that will benefit other audiences, such as chemical industry stakeholders and first responders, but noted that, as this is not covered by the ABEO's mandate, such a request would need to be supported by the Director-General or the Secretariat.

9.4 Ms Sánchez-Bravo further stated that the impact and sustainability of educational resources are critical factors being reviewed and evaluated by the ABEO. This evaluation process is also being supported by the Secretariat through a series of questionnaires. Finally, it was noted that accreditation of courses for use by universities is an interesting idea but that this would require further consultation with the relevant ministries of education or education networks.

10. AGENDA ITEM TEN – Update on activities at the OPCW Centre for Chemistry and Technology

10.1 Mr Keegan McGrath, Senior Policy Officer in the Office of Strategy and Policy, provided an update on the ChemTech Centre and the activities and events which have taken place since its inauguration in May 2023. He introduced the ChemTech Centre, noting that it would enhance the Secretariat's capacity in research, analysis, training, and capacity building, and would reinforce verification and inspection capabilities, as well as strengthen the ability of the Secretariat to support States Parties in implementing the Convention. He also outlined the different programmes and activities that are taking place, as well as priority new programmes for the Secretariat.

10.2 Many of the activities will be a continuation or enhancement of existing activities, and Mr McGrath provided an indicative breakdown of the types of activities being carried out at the ChemTech Centre, as well as activities by division or office. Examples of notable events held at the ChemTech Centre include the annual Symposium on Women in Chemistry on 19 and 20 June 2023, the annual briefing for Permanent Representations to the OPCW based outside of the Netherlands on 3 November 2023, and the OPCW OEWG-T table-top exercise on 20 and 21 November 2023.

10.3 New programmes and activities have also been identified and prioritised (S/2102/2022, dated 30 September 2022) that will strengthen the ability of the Secretariat to fulfil its mandate more effectively. These are grouped into the following areas: enhancement of the OPCW Laboratory capabilities; inspectors' routine and non-routine readiness and training; international cooperation and assistance; and knowledge management and scientific collaboration.

10.4 Some of the new programmes include: chemical forensics analytical method development; biotoxin analysis; development of test and validation capabilities for equipment; a train-the-trainer course on chemical emergency response and preparedness; a workshop on preventing illicit transfers of chemicals; and a new OPCW Fellowship Programme. Many of these have already started, with the others in final development, and are all funded via voluntary contributions from States Parties.

10.5 The SAB Chairperson enquired as to whether there was a central coordinating body within the OPCW keeping track of all the activities being undertaken at the ChemTech Centre. It was stated that this was being done internally, with various coordination processes overseen directly by the Director-General.

11. AGENDA ITEM ELEVEN – Overview of international cooperation, assistance, and protection programmes

11.1 Mr Sergey Zinoviev, Special Advisor on international cooperation programme planning and coordination in the ICA, provided an overview of the Division's programmes. He recalled that the objective of the ICA programme is to assist States Parties in their efforts to meet their obligations under the Convention and thereby enable them to achieve its full and effective implementation. This is facilitated through the coordinated provision of capacity-building support and technical assistance, and helps promote the social and economic development of States Parties.

11.2 In pursuing this mission, the Secretariat runs a portfolio of capacity-building programmes to foster the cooperation of Member States on legal, industrial, scientific, and technical matters relating to the promotion of the peaceful, safe, and sustainable use of chemicals. These programmes support States Parties in developing and improving their protective capacity against chemical weapons, in augmenting capacities to counter chemical terrorism and respond to chemical incidents, and in ensuring the safe and secure use of chemicals throughout their life cycles.

11.3 The ICA offers capacity building to stakeholders in Member States relating to Articles VI (declarations), VII (national implementation), X (assistance and protection), and XI (international cooperation), as well as in certain cross-cutting areas, such as chemical safety and security management, and the OPCW Programme to Strengthen Cooperation with Africa on the Chemical Weapons Convention. Programme areas and subareas aim to develop diverse technical skills, exchange best practices, and foster cooperation in the chemical industry and in small and medium-sized enterprises, within the first responder, scientific, and academic communities, as well as in governments of Member States. Mr Zinoviev provided an overview of ICA programmes and related opportunities for stakeholders, together with selected recent developments, including the enhancement of ICA capabilities with the opening of the ChemTech Centre, the development of the chemical safety and security management toolbox, and the implementation of the chemical emergency response capacity-building exercise for the Africa region (CHEMEX Africa).

11.4 After the presentation, the SAB Chairperson emphasised the continuous engagement of different SAB members in various events implemented by the ICA, and encouraged SAB members to continue sharing their experience and expertise in support of ICA programmes. Several SAB members recounted their positive experiences in assisting with ICA capacity-building events. It was also mentioned that ICA activities are vastly enriched by ensuring a diversity of participants and trainers, with the inclusion of local and regional experts and trainers providing a more compelling learning experience for participants.

12. AGENDA ITEM TWELVE – Inspectorate Division in 2024: The way forward

12.1 Mr Ildefonso CamposVelarde, Director of the Inspectorate Division, gave an overview of the activities, organisation, and future direction of the Inspectorate. He set out the three areas of its mission—namely, implementing Articles IV, V, and VI of the Convention; ensuring preparedness for contingency operations; and supporting the provision of assistance to protect against the use of chemical weapons in accordance with Article X. The core business of the Division relates to inspections, which covers not only inspection planning activities, but also ensuring that inspectors are trained and equipped to conduct all types of missions.

12.2 The Director of the Inspectorate recalled the types of inspections and associated equipment, highlighted the wide variety of working environments, and outlined the three phases of the inspection process: pre-mission activities, in-country activities, and subsequent activities at the OPCW Headquarters. He underscored the importance of inspector training to develop competencies not only in chemistry, but also relating to equipment and other safety and security processes. The ChemTech Centre has vastly increased the Inspectorate's training capabilities, accounting for 67% of total training days since its inauguration.

12.3 In 2023, discussions started on the future organisation of the Division, triggered by three factors: the completed destruction of declared chemical weapons stockpiles; rapid advances in science and technology; and the commissioning of the ChemTech Centre. These discussions identified that the Inspectorate's capabilities with respect to chemical weapons demilitarisation must be preserved, and that operational readiness and technical skills relating to contingency operations should also be maintained. It was further identified that Article VI inspections must keep pace with developments in science and technology, and that the ChemTech Centre should be leveraged to strengthen verification and promote international cooperation.

12.4 Mr CamposVelarde outlined the major challenges and opportunities that the Division faces, including the re-emergence of chemical weapons, changes in manufacturing processes, and developments in technology, and recognised that the Inspectorate needs to be prepared to react and respond. After identifying gaps and opportunities in view of the current and future challenges, the OPCW undertook a multi-step approach to reorganise the Division. The aim of the reorganisation, which took effect at the start of 2024, is to create a "synergised" Division with a flexible and agile workforce and optimised resources. He noted that the transition from strategy to actions started in 2024, and is being carried out in parallel with business-as-usual activities. Initiatives are being introduced slowly and stepwise, and include scenario-based strategic training and the evaluation of emerging technologies, especially AI, on the work of the Inspectorate.

12.5 Following the presentation, knowledge management, staff tenure, and evolving skills and competencies were raised as important considerations for the future. The Director of the Inspectorate indicated that inspectors with biochemistry knowledge will be recruited this year and additional expertise, such as in law enforcement, may be sought in the future. Retaining chemical weapons munitions expertise remains critical, although the recruitment pool is decreasing. The SAB Secretary proposed that the Board note the scientific and technological challenges faced by the Inspectorate and consider how it can address them in the course of its work.

13. AGENDA ITEM THIRTEEN – CBRN defence innovation in the Austrian armed forces

13.1 Dr Gerald Bauer, a research manager in the Austrian Ministry of Defence, provided an overview of CBRN innovations in the Austrian armed forces. He opened his presentation by outlining the current chemical testing and evaluation capabilities. The CBRN community in Austria is small, and there are limited resources, particularly regarding laboratory infrastructure for the unambiguous identification of Schedule 1 chemicals. The Austrian armed forces have compensated for these capability gaps by adopting a highly collaborative approach with nearby countries and leveraging complementary capabilities. These valuable partnerships have enabled a significant amount of innovative research to be undertaken in the field of chemical defence, and Dr Bauer summarised several current and planned projects.

13.2 To augment the currently limited field-detection capabilities for Schedule 1.A.13, 1.A.14, 1.A.15, and 1.A.16 chemicals, referred to as "fourth-generation agents or FGAs" by Dr Bauer, a procedure to optically detect them using handheld forensic light sources has been developed in collaboration with Spiez Laboratory in Switzerland. Multiple light sources with a range of wavelengths, based on ultraviolet, laser, visible light, and light-emitting diode (LED) sources, were tested against a total of 11 FGAs, traditional chemical warfare agents, and a number of precursors. The chemicals were tested in clear glass containers and also deposited on a variety of surface types, including metal, rigid plastics, and blue nitrile gloves. Under blue light, the chemical warfare agents fluoresced, enabling easy detection. Furthermore, common disinfectants, ethanol, and water, did not display any fluorescence and the precursors to one of the FGAs showed reduced or no fluorescence, enabling effective differentiation between them and the chemical warfare agents themselves. Fluorescence could be used as a screening tool to advise where to collect samples for laboratory analysis. Fluorescence could not be discerned on porous or blue surfaces, such as nitrile gloves, and surfaces that absorb light across the visible spectrum, such as black plastics. Moreover, different synthesis and purification approaches gave rise to different observed light intensities for the same FGA. Dr Bauer stated that this collaboration with Spiez Laboratory will continue in order to develop the procedure further, and noted that some of this research has been published.[11]

13.3 Dr Bauer described two current projects integrating unmanned vehicles with sensors. The semi-autonomous chemical aerial reconnaissance system is a UAV-based system fitted with a stand-off detector (Falcon 4G) and air sampling capability, with potential

[11] Gerald Bauer, Agnes Wildauer, Günter Povoden, Benjamin Menzi, and Christophe Curty. 2023. "Crime Scene Novichok—Optical Detection of Fourth-Generation Agents (FGAs) Using Handheld Forensic Light Sources." Forensic Sciences 3(2): 231–44. doi:10.3390/forensicsci3020017.

applications in chemical safety and security in the chemical industry and at chemical incident sites. Specially designed carbotrap tubes are used to sample the air, and a laser scanner, mounted at the front of the UAV, maps the terrain in real time, enabling safe lowering zones to be identified. Despite weight and size constraints preventing a gimbal system (a mechanical device that allows the detector to remain steady despite external movement) from being integrated, the system was shown to be useful for sampling gas clouds, and may have applications for ground contamination. The CBRN Surveillance as a Service project, developed under the European Union Permanent Structured Cooperation framework, features a comprehensive sensor system integrated with two UAVs and an unmanned ground vehicle to support the common operational CBRN picture in mission control. A demonstrator of the system has already been developed, and a full operational capability should be reached in close cooperation with several Member States of the European Union.

13.4 The Austrian armed forces are employing a body-on-a-chip approach to develop a novel detection concept based on symptoms rather than identifying the specific chemical compound.[12] This integration of cultured cells, skin models, microfluidic systems, and electrochemical sensors could lead to a more reliable model than current detection approaches, and also afford opportunities for environmental safety, workplace safety, or toxicity investigations.

13.5 Dr Bauer noted that other projects include determining whether DNA samples contaminated with sulfur mustard can still be used for DNA profiling; producing training videos on chemical warfare agents; developing a comprehensive database on chemical point detectors used in live agent training; exploring the utility of heating systems to enable the detection of low-volatility chemicals in the field; and developing chemical triage techniques for personnel and high-value equipment.

13.6 Dr Bauer's presentation generated significant discussion among the SAB members, and the optical detection of FGAs was of particular interest. The wavelengths, sensitivity, types of materials, and surface properties were discussed. When asked whether this approach could be applied to protein-based biotoxins, Dr Bauer explained that the precise mechanism responsible for the fluorescence is currently unknown, although several hypotheses are being explored. He intends to determine the mechanism and ascertain which chemicals, including biotoxins, may undergo this visible change, rather than conducting extensive and unnecessary laboratory testing.

13.7 The Board also posed several questions relating to the UAV-mounted sensors, including the types of sensors used, the degree of ruggedisation, and their possible application in detecting toxic industrial chemicals at plant sites, as well as biological warfare agents. Dr Bauer explained that biological agents are not the focus of these projects.

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12 Helene Stuetz, Eva Reihs, Winfried Neuhaus, Maren Pflueger, Harald Hundsberger, Peter Ertl, Christian Resch, Gerald Bauer, Guenter Povoden, and Mario Rothbauer. 2023. "The Cultivation Modality and Barrier Maturity Modulate the Toxicity of Industrial Zinc Oxide and Titanium Dioxide Nanoparticles on Nasal, Buccal, Bronchial, and Alveolar Mucosa Cell-Derived Barrier Models." International Journal of Molecular Sciences 24 (6): 5634. doi:10.3390/ijms24065634.

14. AGENDA ITEM FOURTEEN – Persistent nerve agents

14.1 Ms Helen Mearns, from the Chemical Security Analysis Center (CSAC) in the Department of Homeland Security (DHS), United States of America, opened her presentation with an overview of the DHS enterprise, the role of the Science and Technology Directorate, and the work of the CSAC. She then informed the SAB that the DHS Office of Countering Weapons of Mass Destruction held a four-day workshop in August 2022 that brought together over 150 experts and participants from across the federal government in the United States, state and local first responder communities, and international partners. The meeting focused on a wide variety of topics related to emerging chemical threats, including an assessment of current capabilities and plans to make future improvements. While the workshop primarily focused on domestic preparedness to specific emerging chemical threats, the discussions and issues raised were broadly applicable to preparedness for many types of chemical attack.

14.2 Following the workshop, the CSAC identified a pressing need within consequence management research to determine decontamination-generated degradation products of persistent nerve agents. Working with the United States Environmental Protection Agency, bleach was determined to be the most widely and readily available decontaminant. For this reason, the CSAC is studying chemical decontamination using bleach in order to identify the components of decontamination.

14.3 This project is currently halfway completed and being undertaken at two separate laboratories where four persistent nerve agents are being studied. The reaction kinetics of these agents with industrial-grade bleach containing 7.5% sodium hypochlorite in alkaline aqueous solution is followed by nuclear magnetic resonance (NMR) spectroscopy. Final products are then identified using NMR spectroscopy, liquid chromatography-mass spectrometry (LC-MS), and gas chromatography-mass spectrometry (GC-MS). The structures and relative abundance of the various products formed will then be determined. While both laboratories are investigating the same four persistent nerve agents, the methods and scales used are different. Later research will determine the mechanism of action of the bleach on the agents and the toxicity of the decontamination products, investigate permeation through gloves, and safely enable waste transport and disposal.

14.4 Board members asked a series of technical questions regarding the specific conditions of the experiments, including the concentration of the sodium hypochlorite, its pH, the dilution ratio, and the commercial availability of the decontaminant. Regarding the degradation mechanism (oxidation and/or hydrolysis) and the active species in this process, Ms Mearns stated that the working hypothesis is that both free chlorine and sodium hydroxide are responsible, and that studying the unknown compounds may yield more conclusive results.

14.5 Due to resource constraints, the toxicity of the degradation products will only be determined by computational toxicology techniques. If further toxicological studies are required, an animal model could be used. Ms Mearns confirmed that the permeation testing of the gloves will involve applying neat agent and neat degradation products to the gloves. Finally, the SAB Secretary highlighted that the scarcity of information on certain persistent nerve agents is challenging for the Secretariat, particularly regarding the health and safety of inspectors on missions, and he encouraged information sharing.

15. AGENDA ITEM FIFTEEN – Upcoming workshop on deployable equipment

15.1 Mr Ardalan Zargham and Mr Davin Carter, from the Inspectorate Division, introduced the rationale and planning for an upcoming workshop on deployable equipment. The OPCW is susceptible to the constantly evolving advances in science and technology. This manifests itself both in the threats the Organisation may face, as well as the risk of not staying current in the technology that it uses in its work. With regard to the latter point, the Secretariat is still subject to C-I/DEC.71* (dated 30 November 2010), which lays down the technical specifications of inspection equipment, such as general inspection, administrative, analytical, non-destructive evaluation, and medical equipment for use during missions, which prevents the Secretariat from benefiting from more up-to-date equipment.

15.2 A more agile and responsive approach is required to keep pace with evolving requirements and to ensure that an effective deployment capability is maintained. The ChemTech Centre is critical to the OPCW remaining fit for purpose by enabling the Secretariat to conduct activities that were not previously possible. For example, the establishment and maintenance of an equipment test bed would assist in testing available equipment against OPCW needs and criteria, and subsequently help it identify equipment that will augment its mission capability.

15.3 Mr Carter and Mr Zargham presented their initial thoughts for a workshop on deployable equipment, focusing on defining the approach and priorities. They highlighted the need to define plausible scenarios of misuse and subsequent deployment scenarios that would anchor the conversation. They noted the importance of defining requirements and capabilities, as well as identifying current capability gaps. These would then inform the request for equipment recommendations and pertinent information, and clarify the approach for the establishment of an equipment test bed and the focus of the workshop.

15.4 SAB members were asked to contribute their thoughts and ideas for this workshop, and were invited to play an integral role in its planning and execution. An in-depth discussion then ensued, with many Board members sharing their ideas to help refine the scope of the workshop. Board members were encouraged to continue their discussions on this topic, both amongst themselves and with Inspectorate staff throughout the week. SAB members interested in contributing further to this workshop were also asked to notify the SAB Chairperson or Vice-Chairperson of their interest.

16. AGENDA ITEM SIXTEEN – OPCW Laboratory at the Centre for Chemistry and Technology: One year onward

16.1 Mr Adriaan Marais, a Senior Analytical Chemist at the OPCW Laboratory, provided an overview of the work of the Laboratory and highlighted various activities and accomplishments since it relocated to the ChemTech Centre in 2023. He opened his presentation with an introduction to the Laboratory staff and then provided a brief overview of the key tasks undertaken at the Laboratory, namely providing support to sampling and analysis, maintaining ISO 17025 and ISO 17043 Standard accreditation, and providing capacity-building training courses to States Parties.

16.2 In terms of supporting sampling and analysis, the OPCW Laboratory compiles the OPCW Central Analytical Database (OCAD) and maintains the network of OPCW designated laboratories. Mr Marais described the two types of designated laboratory, one being for environmental samples and the other for biomedical samples. He reported that, as of April 2024, there are 28 designated laboratories in 23 States Parties for the analysis of environmental samples, highlighting the recent addition of laboratories in Algeria and Poland, and 19 designated laboratories in 14 States Parties for the analysis of biomedical samples. Mr Marais also outlined the proficiency test process used to test the competencies of the designated laboratories on an annual basis.

16.3 He recalled the three ongoing non-routine missions: the Declaration Assessment Team, the OPCW Fact-Finding Mission in Syria, and the Investigation and Identification Team (IIT). In this context, he emphasised the importance of maintaining analytical capabilities in the designated laboratories through proficiency testing and the augmentation of their chemical forensics capabilities. The elucidation of the method of synthesis of sulfur mustard used by the Islamic State in the Levant, as described in the fourth report of the IIT (S/2255/2024, dated 22 February 2024), was presented as an example of the effective harnessing of chemical forensics techniques.

16.4 To ensure that designated laboratories are fit for purpose in terms of chemical forensics, Mr Marais noted that four key areas have been identified for technical development: reporting and probabilistic interpretation; statistical processing and feature comparison; data processing methods and quality control; and quantitative analysis and measurement uncertainty.

16.5 There are currently two chemical forensics research projects being undertaken at the OPCW Laboratory. The first aims to develop chemical forensics analytical methods with an application beyond scheduled chemicals based on stable isotope analysis of chlorine and sulfur. This work will contribute to production route attribution, sample matching, and the identification of discriminating markers. The second project also aims to develop chemical forensics analytical methods using inductively coupled plasma-tandem mass spectrometry (ICP-MS/MS), with a specific focus on the analysis of biotoxins. By leveraging ICP-MS/MS and liquid chromatography-tandem mass spectrometry (LC-MS/MS) data, this approach aims to develop a capability to attribute the geographical origin of biotoxins, as well as to elucidate production or isolation techniques.

16.6 Mr Marais briefly presented some results from previous work related to these projects. Compound-specific stable chlorine isotope analysis (CSIA-Cl) has enabled differentiation between chlorinated phenol products formed from exposure to chlorine gas and those from exposure to common chlorinating agents, such as bleach.[13] With regard to general method development for the analysis of biotoxins, work at the Laboratory has focused on saxitoxin. An LC-MS method based on derivitisation was developed, affording good retention and separation of different paralytic shellfish poisoning biotoxins on C18 columns. The microsynthesis facility at the ChemTech Centre will play an important role in the development of investigative science and

[13] Stephanie Lau, Sonali Abraham, and A. Lynn Roberts. 2016. "Chlorination Revisited: Does Cl^- serve as a Catalyst in the Chlorination of Phenols?" Environmental Science and Technology 50(24): 13291-13298. doi:10.1021/acs.est.6b03539.

technology at the Centre and support the expansion of the OCAD. Wet chemistry—initially for the synthesis of non-toxic materials—is planned to start by the end of 2024. Mr Marais went on to say that collaboration between the OPCW Laboratory and designated laboratories will be crucial for the success of this endeavour. He also highlighted a number of capabilities that need to be considered and strengthened, including synthesis knowledge from organic chemists, semi-quantitative analysis, trace analysis, data mining, probabilistic models, and a repository of reference standards.

16.7 The Board enquired further about the Laboratory and the designated laboratory programme, specifically regarding current engagements with academic institutions; plans to accredit additional designated laboratories on the African continent; current work done on biomedical samples; and the continued reliance on voluntary contributions to the OCAD from both Member States and designated laboratories. A question was also raised as to the Laboratory's ability to identify novel synthesis routes, with comparisons made to the multiple newly identified synthesis routes for opioids. The work of the IIT was also the subject of discussion in the context of understanding the origins of the impurities present in sulfur mustard produced via the Levinstein process, that is route attribution chemical markers. Finally, the viability of a future forensics-specific database based on different synthesis pathways and products was discussed with Mr Marais, noting that such a task would require the expertise and capacity of OPCW designated laboratories.

17. AGENDA ITEM SEVENTEEN – Chemical markers for chlorine release in environmental samples

17.1 Dr Crister Åstot, from the Swedish Defence Research Agency (FOI), presented on chlorine markers in environmental samples, noting their significance in highly populated urban war zones where concrete rubble, construction wood, and polymeric materials are commonly present. Dr Åstot and co-workers from the Finnish Institute for Verification of the Chemical Weapons Convention (VERIFIN), the Netherlands Organisation for Applied Scientific Research (TNO), and Spiez Laboratory have used chlorination experiments to investigate chlorinated organic compounds formed in concretes and woods exposed to chlorine gas or bleach. Concretes of different ages and origins were exposed to chlorine and subsequently analysed by gas chromatography-high-resolution mass spectrometry (GC-HRMS) and LC-HRMS. In old concretes, different profiles of chlorinated organic compounds were found depending on the chlorine concentration and type of chlorination agent used. Bleach and low concentrations of chlorine produced more lightly chlorinated compounds than "neat" chlorine gas (namely, concentrations in excess of 500 parts per million), and the latter gave rise to highly chlorinated compounds, such as tetrachlorophenol and trichlorotoluene.[14]

17.2 In previous work carried out by Spiez Laboratory, conifer wood exposed to chlorine gas has been shown to contain a combination of the chlorinated markers bornyl chloride and trichlorophenol.[15] Bornyl chloride is produced by the nucleophilic chlorination

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14 Nurhazlina Hamzah, Karin Hojer Holmgren, Crister Åstot, Marcel J. van der Schans, Leo de Reuver, and Paula Vanninen. 2023. "Chlorinated Organic Compounds in Concrete as Specific Markers for Chlorine Gas Exposure." Journal of Hazardous Materials, 459 132332. doi:10.1016/j.jhazmat.2023.132332.

15 This work was presented to the SAB at its Twenty-Third Session; see SAB-23/1 (dated 22 April 2016).

reaction of hydrogen chloride on the terpene α-pinene, and chlorinated phenols are known to result from the reaction of chlorine and the phenolic biopolymer lignin. Present in both softwood (coniferous) and hardwood (deciduous) trees, lignin is the "glue" that holds wood fibres together. Dr Åstot noted that environmental pollutants, including chlorinated phenols and dioxins that were generated in the pulp and paper industry in the 1980s, were due to the reaction of elemental chlorine—the bleaching agent—with lignin. He described his recent work on lignin, which has shown that the highly chlorinated phenol tetrachlorophenol is present in both chlorinated softwood and hardwood. Taken together, the reported chemical markers provide a method to confirm exposure of any wood to chlorine gas.[16]

17.3 Lignin is not only present in wood, but has also been identified in old concretes using pyrolysis GC-MS analysis. Dr Åstot noted that old concretes have a higher organic matter content than modern concretes, possibly arising from the difference in source selection and the level of processing of natural aggregates, such as sand and gravel, in modern concrete manufacturing. Samples of modern concrete spiked with lignin were exposed to chlorine, resulting in identical chemical profiles, including the presence of tetrachlorophenol, to old concretes. Dr Åstot concluded with the following advice for designated laboratories: Use large sample sizes of 5 – 10 g of concrete to allow low levels of chlorinated compounds to be detected.

17.4 In the question-and-answer session that followed, the potential use of thermal desorption analysis was raised. Replicating realistic exposure conditions experimentally was discussed in terms of the kinetic rates of reactions of chlorine gas with moisture in the air, and the chlorination of concrete in open versus enclosed spaces. Asked whether this methodology could be used in living trees, Dr Åstot clarified that this is not possible, as these experiments used dead construction wood, whereas in living trees the wood is a wet tissue surrounded by the living cambium tissue and the bark of the trunk.

18. AGENDA ITEM EIGHTEEN – Machine learning for rapid detection of novel chemical weapons

18.1 Prof David Wishart, from the University of Alberta, Canada, described the use of in silico analytical chemistry to accelerate identification of an emerging class of synthetic drugs called novel psychoactive substances (NPSs). In silico analytical chemistry leverages machine learning and AI in applications such as generative modelling, predictive spectroscopy, and chemical language models (CLMs), to predict the structures and properties of compounds without requiring reference standards or spectra. These approaches aim to allow for more rapid identification of NPSs than traditional methods.

18.2 Prof Wishart described a CLM approach involving conversion of chemical structures into Simplified Molecular Input Line Entry System (SMILES) strings, which are then augmented and used to train a deep neural network called a long short-term memory network. This model uses the chemical syntax learned to generate millions of new NPS structures. Competitive Fragmentation Modeling for Metabolite Identification (CFM-ID), a programme developed by Prof Wishart and his team, uses machine

[16] Peter Siegenthaler et al. 2024. "The chlorine signature in conifer wood." (Manuscript in preparation).

learning to predict MS/MS spectra which, especially when combined with other information such as HRMS data, aids NPS identification.[17, 18]

18.3 The DarkNPS database is a collection of deep learning-enabled predictive spectroscopy data on potential NPSs. More than 90% of NPSs identified by forensic laboratories in the two years after the database was created in 2019 were found to be already in the database. The quality of the predicted MS/MS spectra by CFM-ID have been improved with a technique called transfer learning and a series of programmes to enhance the speed and accuracy of NPS identification. The use of machine learning methods to predict multi-step transformation products of NPSs was discussed. Finally, Prof Wishart underlined the relevance of CLMs and predictive spectroscopy for the prediction of novel chemical weapons structures and spectra, and the enhancement of public safety and regulatory control of novel toxic substances and their metabolites.

18.4 Following the presentation, the role of AI and machine learning in the future of personalised medicine was raised in relation to the limitations of existing pharmaceutical treatments of mental health conditions. Prof Wishart explained that while his work focuses on chemical forensics applications, there are certainly many potential applications for medicine and public health. A question on the use of a CLM as opposed to other models prompted a discussion on the potential use of other learning methods and models such as fragment-based approaches. Prof Wishart noted that CLMs are advantageous due to their capacity to learn "chemical syntax" related to bonds and structures.

18.5 Additional questions related to training and validation datasets, minimum dataset size, and the problems posed by insufficient chemical toxicity data. Prof Wishart highlighted the utility of data augmentation—expanding a small dataset with artificial data—for CLMs and large language models. While there are issues with data extrapolation and interpolation, there are some very successful examples.

19. AGENDA ITEM NINETEEN – Overview of spray unmanned aerial vehicles in agriculture

19.1 Prof Steve Li from the University of Auburn, United States of America, spoke to the Board on recent developments in agricultural UAVs and drone technology. He conducts 50 to 100 field experiments every year to study pesticide efficacy, application technology, and drift management. His presentation focused on current applications of spray UAVs in the United States (including for row crops, horticultural crops, non-crop areas, bodies of water, and forestry), current regulations related to spray UAVs in the United States, and global development trends in spray UAVs.

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17 Michael Skinnider, Fei Wang, Daniel Pasin, Russell Greiner, Leonard Foster, Petur Dalsgaard, and David Wishart. 2021. "A deep generative model enables automated structure elucidation of novel psychoactive substances." Nature Machine Intelligence 3 (11): 973–84. doi.org/10.1038/s42256-021-00407-x.

18 Fei Wang, Daniel Pasin, Michael Skinnider, Jaanus Liigand, Jan-Niklas Kleis, David Brown, Eponine Oler, et al. 2023. "Deep Learning-Enabled MS/MS Spectrum Prediction Facilitates Automated Identification of Novel Psychoactive Substances." Analytical Chemistry 95 (50): 18326–34. doi:10.1021/acs.analchem.3c02413.

19.2 There has been a rapid adoption of spray UAVs in the United States of America in the last three years. Many custom application businesses have been established to provide commercial pesticide application services to farmers and landowners in various states. Current field trials show that the efficacy afforded by spray UAVs at low spray volumes (19 to 28 litres per hectare) is mostly comparable to spray planes and ground sprayers. Meanwhile, spray UAV technology has demonstrated a unique strength in its ability to spray areas unsuitable for ground sprayers. These include fields with odd shapes or with terraces and obstacles, hard-to-reach areas, bodies of water, and tall crops.

19.3 To legally spray with UAVs in the United States of America, licences and permits are required from the Federal Aviation Administration and the Department of Agriculture. Pesticide labels approved by the Environmental Protection Agency must specifically allow aerial applications for UAVs. There are currently, however, no restrictions in the United States in respect of whom agricultural drones may be sold to, nor are background checks carried out.

19.4 Prof Li outlined a number of developments regarding agricultural UAVs of relevance to the Board. Traditional multi-hydraulic nozzles have been replaced by rotary atomizers (spinning discs) in newer spray UAVs, allowing them to spray more viscous solutions efficiently. The size of the droplets dispersed by sprayers is decreasing, with a diameter of 20 μm now possible, which is especially useful in mosquito spraying applications. These newer UAVs are continuing to grow in size, fly faster—reaching speeds of 50 km per hour—and are being equipped with increasingly sophisticated navigation and collision avoidance systems. Their battery lives are rapidly increasing, and more efficient alternatives to the current battery type are starting to be researched. This is primarily to reduce the costs borne by drone operators, thereby increasing revenue. Beyond visual line of sight (BVLOS) flying is challenging to achieve due to the loss of connection between the UAV and the controller, and is generally illegal without special permission. However, it is increasingly possible due to better connectivity by leveraging mobile telecommunications networks.

19.5 The Board went on to discuss the agricultural implications of the technology with Prof Li, including the shift to the use of drones, the models of drones used, and the use of other applicants, besides herbicides and fungicides. The implications of this technology for malicious use were discussed, including flying height, payload, and droplet size. The additional regulatory hurdles, or lack thereof, were also discussed, particularly with regard to existing regulation of large agricultural drone sales and ease of access to the technology.

20. AGENDA ITEM TWENTY – Solving big problems with small things

20.1 Prof Omar Farha leads a research group at Northwestern University, United States of America, which develops a range of chemical and materials science solutions for energy, environmental, and defence applications. His presentation principally focused on a series of MOFs, whose structures and functions were inspired by nature, that were developed specifically for the catalytic detoxification of four nerve agents, VX, sarin, soman, and tabun. In 2010, the Farha research group started to consider MOFs as alternatives to activated charcoal, and they considered that not only could their highly porous structure and sponge-like properties facilitate the adsorption of toxic chemicals, but their potential to catalytically detoxify the chemicals could also offer a significant

advantage over activated carbon. Furthermore, their inherent tunability, arising from the vast possible combinations of inorganic metal clusters or ions and organic linkers, offers greater operational flexibility.

20.2 The first MOF selected, UiO-66, was inspired by a zinc-based phosphotriesterase, an enzyme which hydrolyses organophosphorus compounds, but zirconium was chosen rather than zinc as it is a better Lewis acid.[19] This MOF took around 10 minutes to detoxify 50% of the nerve agent simulants through hydrolysis. Prof Farha found that opening up the cavity by using UiO-67 and tailoring the chemical nature of the organic linkers improved the accessibility to active sites by increasing the size of the porous network, and led to a reduction in detoxification time.[20] Furthermore, it was determined that incorporating an amino functional group and moving it to the ortho ring position increased the detoxification efficiency.[21]

20.3 While the catalyst was shown to be effective, the reaction conditions for screening necessitated the presence of water, which is not representative of employment of the catalyst in a real-world operational environment. It was subsequently determined that an external water source was not required provided that the relative humidity exceeded 15%.

20.4 Building on these successes, the research group's focus shifted to developing MOFs suitable for impregnation on textile fibres for incorporation into protective suits. The hydrophilic properties of the fibres were increased to draw in more water. Consequently, no additional water was required, and no volatile base was needed. Different metals were explored, and while cobalt and nickel proved poor choices, copper resulted in fast conversion, with the reaction reaching completion.

20.5 Through Numat, a company formed in 2013, MOFs can be designed in silico, tested on a small scale, and subsequently scaled up to a production scale in the order of tonnes. The wealth of data on the MOFs collected over the last decade is being leveraged to significantly reduce the time between MOF design and large-scale production from 5 to 25 years to a mere six months to two years. It was noted that scale-up and commercialisation of the MOFs have been comparatively successful.

20.6 After the presentation, the Board enquired about topics such as the reusability of MOFs, their diffusivity rates, the potential wider spectrum of substances that could be treated, and the resulting products of the reaction. Prof Farha answered that pore area was a key factor in diffusivity, and that for optimal performance there needed to be a balance between the diffusivity rate and the detoxification.

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19 Kin-Yiu Wong and Jiali Gao. 2007. "The Reaction Mechanism of Paraoxon Hydrolysis by Phosphotriesterase from Combined QM/MM Simulations." Biochemistry 46:13352–69. doi:10.1021/bi700460c.

20 Jasmina Hafizovic Cavka, Søren Jakobsen, Unni Olsbye, Nathalie Guillou, Carlo Lamberti, Silvia Bordiga, and Karl Petter Lillerud. 2008. "A New Zirconium Inorganic Building Brick Forming Metal Organic Frameworks with Exceptional Stability." Journal of the American Chemical Society 130(42): 13850–51. doi:10.1021/ja8057953.

21 Michael Katz, Joseph Mondloch, Ryan Totten, Jin Park, Sonbinh Nguyen, Omar Farha, and Joseph Hupp. 2013. "Simple and Compelling Biomimetic Metal–Organic Framework Catalyst for the Degradation of Nerve Agent Simulants." Angewandte Chemie 53(2): 497–501. doi:10.1002/anie.201307520.

20.7 Prof Farha stated that the aim of the research was not to develop a single MOF that could detoxify a broad spectrum of chemical warfare agents, but to develop MOFs to detoxify specific agents with high efficacy. These individual MOFs could potentially be combined to give broad-spectrum protection. Additionally, Prof Farha mentioned that many other research groups are evaluating the efficacy of MOFs on toxic industrial chemicals, including chlorine, ammonia, and chemical warfare agents, such as phosgene. Prof Farha indicated that his research group would like to explore MOFs with heterobimetallic metal clusters, but that their synthesis currently remains challenging.

20.8 Additional questions centred on the use, and reuse, of these MOFs in respirator canisters and in fabrics for protective clothing, as well as their use compared to the industry standard, activated carbon. Prof Farha made clear that the MOF-functionalised suits are not intended to be used more than once. Unlike for other materials, such as activated carbon, humidity improves the catalytic activity of MOFs, accounting for their suitability as in situ decontaminating agents. The MOFs are being evaluated as additional materials for incorporation into protective equipment to enhance overall protection, and not as a replacement for activated carbon.

21. AGENDA ITEM TWENTY-ONE – Navigating the VX nerve agent incident at Kuala Lumpur International Airport 2, Malaysia: Lessons learned, best practices, and the challenges ahead

21.1 Dr Raja Subramaniam, from the National Authority for Chemical Weapons Analysis in Malaysia, briefed the Board on the nerve agent incident that took place in Kuala Lumpur International Airport 2, Malaysia, on 13 February 2017. His briefing covered the chemical weapons incident management and highlighted key lessons learned, best practices, and challenges, principally from the laboratory and judicial perspectives. Dr Subramaniam highlighted the complexity of the ensuing multifaceted inquiry, which involved a number of different agencies and experts. He also stressed the importance of immediate action and interdisciplinary collaboration in mitigating chemical hazards, and noted that an article on the incident had recently been published.[22]

21.2 Subsequent prompt laboratory analyses played a pivotal role in confirming VX nerve agent exposure through the examination of tissue, biomedical fluid, clothing, and environmental samples. Dr Subramaniam highlighted the essential need for States Parties to possess adequate analytical methodologies for identifying and characterising chemical agents. The incident further underscored the imperative for sustained global cooperation and capacity-building efforts under Article X of the Convention to enhance the preparedness and response capabilities of States Parties against the covert dangers of chemical weapons.

21.3 Following the presentation, the Board asked a series of questions about the case. There were short discussions about the validity of the binary agent theory, sample collection locations, and the victim's autopsy data. This was followed by a number of questions about the procedures involved in the conduct of the criminal trial, the role of the laboratory, and regarding Dr Subramaniam as a chemist working with the judicial system, as well as the challenges for experts in trial proceedings.

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22 Raja Subramaniam. 2024. "VX Nerve Agent Incident: Lessons Learned, Best Practices, and the Challenges Ahead." CBNW. (https://nct-cbnw.com/vx-nerve-agent-incident-lessons-learned-best-practices-and-the-challenges-ahead/).

22. AGENDA ITEM TWENTY-TWO – From batch to flow: Advancing synthetic organic chemistry through technological innovation

22.1 Prof Tim Noël leads a research group at the University of Amsterdam in the Netherlands dedicated to pushing the boundaries of synthetic organic chemistry by harnessing technology to its fullest potential. His presentation showcased the capabilities of flow chemistry and of self-driving laboratories in advancing synthetic organic chemistry. He also highlighted the many advantages of microscale flow reactors, including enhanced safety, reduction in human error, scalability, and reproducibility.

22.2 Prof Noël's presentation focused firstly on photocatalysis, which has attracted increasing interest over the past two decades due to a number of factors, such as the drive towards sustainable chemistry, the availability of small-diameter capillary "reactors", and access to affordable LEDs as the required light source. While the use of photocatalysis is well established in medicinal chemistry, where screening reactions only require milligram-scale production, it has not been widely adopted in process chemistry, where production is on a large scale, due to the high optical power requirement and the associated costs. Furthermore, light penetration depth in batch reactors is limited. Prof Noël noted that flow reactors, which use continuous lengths of small diameter tubing as the reactor, may be utilised to overcome this issue and that scaling could be achieved by either adding flow reactors in parallel—known as numbering up—or increasing the length and/or the diameter of the tube. He subsequently provided a number of examples of challenging chemical reactions that had been successfully performed in flow reactors, including cases where toxic compounds were produced in situ, minimising the storage or use of large amounts of toxic materials.[23]

22.3 Prof Noël introduced "RoboChem", an all-in-one robotic platform that has been designed and developed by his research group, and highlighted the affordability of its components, which supports his objective of democratising technology. RoboChem employs a combination of readily available hardware, customised software, and Bayesian optimisation algorithms to streamline the optimisation, intensification, and scale-up of complex photocatalytic reactions. By operating autonomously, RoboChem reduces the workload and need for extensive expertise in photocatalysis, making it accessible to a wide range of researchers.[24]

22.4 Prof Noël referred to a number of molecules whose reported literature yield was either matched or improved—in some cases significantly—by this robotic platform. Its algorithm optimises reaction conditions by conducting a series of runs in which various parameters are altered and the product is analysed by NMR spectroscopy. RoboChem's "target" is the yield, which it aims to maximise during the runs. Prof Noël noted that some of the decisions it took would not necessarily have been made by a chemist.

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23 Timothy Noël and Eli Zysman-Colman. 2022. "The Promise and Pitfalls of Photocatalysis for Organic Synthesis." Chem Catalysis 2(3): 468–76. doi.org/10.1016/j.checat.2021.12.015.

24 Aidan Slattery, Zhenghui Wen, Pauline Tenblad, Jesús Sanjosé-Orduna, Diego Pintossi, Tim Den Hartog, and Timothy Noël. 2024. "Automated Self-Optimization, Intensification, and Scale-up of Photocatalysis in Flow." Science 383: 6681. doi:10.1126/science.adj1817.

22.5 In the second part of his briefing, Prof Noël presented his research group's work on the on-demand generation of fluorinated intermediates. He noted that there has been growing interest in chemicals containing a trifluoromethyl group, and applications in the pharmaceutical sector have been emerging. However, a proposed ban on per- and polyfluoroalkyl substances by the European Chemicals Agency could affect the availability of fluorinated reagents or intermediates for active pharmaceutical ingredients and active ingredients used in the pharmaceutical and agricultural sectors, respectively.[25] To overcome this potential challenge, the Noël research group has sought to develop environmentally friendly methods to synthesise trifluoromethyl moieties starting from chemicals, such as alkali metal fluorides, which will not be subject to the ban. This approach has been successful and has enabled the late-stage functionalisation of some drug molecules, a powerful strategy in drug development that enhances the optimisation, efficiency, and versatility of creating new and improved therapeutic agents. This on-demand generation approach has also been extended to one of the most important click chemistry transformations, sulfur (VI) fluoride (SuFEx) ligation.[26, 27]

22.6 The Board asked a series of brief, functional questions related to the flow system's mechanisms for working with or resolving clogging, dilution factors, precipitation, and heterogeneous phase reactions, all of which have provided some degree of difficulty over the course of RoboChem's development. It was noted that clogging problems are always a challenge, but the incorporation of ultrasound technology to inhibit the formation of large particles can often successfully overcome this. Members also expressed interest in the time taken for reactions to occur, and the latency between them. Prof Noël noted that reaction times and latency between reactions varied depending on the reaction mechanisms and the analytical equipment used to monitor the results.

22.7 One point of discussion related to cases where the robotic platform and algorithm did not reach an optimised convergence of reaction parameters. Prof Noël noted that this does happen, although the reason can be hard to determine. Sometimes information in the literature is not totally correct, making it difficult to compare the performance of their platform and reported methods. For example, sometimes a specific reaction parameter of importance either is not reported or is not highlighted in the literature. His team may then not assign the correct level of importance to this parameter, thereby unintentionally hampering the ability of the platform to optimise the reaction conditions. The Board members concluded by enquiring about the accessibility of the algorithms, and were informed that they are open access.

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25 Nicholas Tyrrell. 2023. "A Proposal That Would Ban Manufacture, Supply, and Use of All Fluoropolymers and Most Fluorinated Reagents Within the Entire EU." Organic Process Research & Development 27(8): 1422–26. doi:10.1021/acs.oprd.3c00199.

26 Antonio Pulcinella, Prakash Tiwari, Alberto Luridiana, Ken Yamazaki, Daniele Mazzarella, Akshay Sadhoe, Antonella Alfano, Eveline Tiekink, Trevor Hamlin, and Timothy Noël. (2024). "C1-4 Alkylation of Aryl Bromides with Light Alkanes enabled by Metallaphotocatalysis in Flow." doi:10.26434/chemrxiv-2024-7mk1c.

27 Lucia Chiummiento, Rosarita D'Orsi, Maria Funicello, and Paolo Lupattelli. 2020. "Last Decade of Unconventional Methodologies for the Synthesis of Substituted Benzofurans." Molecules/Molecules Online/Molecules Annual 25(10): 2327. doi:10.3390/molecules25102327.

23. AGENDA ITEM TWENTY-THREE – Synthesis of useful and harmful chemicals in the age of computers

23.1 In his briefing to the Board, Prof Bartosz Grzybowski, representing both the Polish Academy of Sciences and the Ulsan National Institute of Science and Technology in the Republic of Korea, focused on how AI in chemistry may be used both to benefit humankind, for example through the development of life-saving drugs, and to cause intentional harm, through the production of hazardous chemicals such as narcotics, explosives, and biotoxins.

23.2 For computers to be effective in helping chemists solve complex synthesis issues such as the production of pharmaceuticals, they need to learn the rules of chemistry. Prof Grzybowski explained that AI systems such as Deep Blue and AlphaZero have learned how to play and win games of chess, as there are fewer than 15 possible moves with well-defined applicability. Conversely, successful organic synthesis using AI is more challenging as these "moves"—in other words the types of chemical reactions—exceed 100,000 and their applicability is contextual and dependent on the specific molecules involved. AI cannot learn the rules of synthesis simply by accessing every chemical publication available, as they will only indicate successful reactions and do not generally provide information on unsuccessful and unproductive reactions, which is critical to this learning process.

23.3 To overcome this limitation, the Grzybowski research group has developed hybrid models that leverage a combination of AI, quantum mechanics, and molecular mechanics, affording the system a greater understanding of the rules of chemistry and leading to viable synthetic plans. In 2017, one of the research group's advanced algorithms, Chematica,[28] was used to generate synthesis routes for several challenging drug compounds, which were subsequently validated experimentally. Prof Grzybowski underscored the fact that experimental validation of AI outputs in chemistry is essential. Since then, their algorithms have been used to synthesise a number of complex natural products, including cephanolide B, and scabrolide A. Despite these successes, Prof Grzybowski noted that there are still some targets that are too complex due to limitations in computing power and memory, but that they will soon be achievable.

23.4 Allchemy[29] is a newer generation product developed by the Grzybowski research group that is not only capable of determining the synthesis routes of natural products, but also classifying the reaction by scale: laboratory-scale (grams), pilot-scale (kilograms), and industrial-scale (tonnes). The algorithm therefore combines the rules of chemistry with the production scales. On an industrial scale, this provides knowledge of all the global processes and how they connect into a network. Using this platform to examine supply chains, Prof Grzybowski has explored how supply chains could be rerouted during feedstock shortages and how the production of the top 51 medicines in the United States of America could be fine-tuned to make the entire industry more efficient, thereby reducing the number of compounds required from 626 to 404 through the identification of common intermediate compounds. He also noted that the platform can be leveraged to identify how

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28 Bartosz Grzybowski, Sara Szymkuć, Ewa Gajewska, Karol Molga, Piotr Dittwald, Agnieszka Wołoś, and Tomasz Klucznik. 2018. "Chematica: A Story of Computer Code That Started to Think like a Chemist." Chem 4: 390-398.

29 https://allchemy.net/.

waste chemicals can be used to generate valuable ones, such as pharmaceuticals. Approximately 300 different pharmaceuticals can be produced from this waste, including a drug to treat leprosy that can be produced from plastic bottles and phenol from coal production.[30]

23.5 Lastly, Prof Grzybowski described some of the harmful substances whose production may be facilitated by AI. He noted that in just 15 minutes an algorithm discovered all possible ways to synthesise fentanyl, involving a total of approximately 350 different chemicals. Of these, only 13 are subject to regulation in the United States of America. For each of the pathways discovered, a fingerprint has been generated that could enable different batches of fentanyl to be differentiated and their origin potentially identified. The Grzybowski research group is looking at the starting materials for typical energetic materials to determine other related materials that could be produced.[31] They have also used the algorithm to generate possible analogues of the so-called novichok chemicals. In closing, Prof Grzybowski discussed how AI systems incorporating an advanced level of chemistry could be used to predict the degradation of chemical warfare agents.

23.6 The Board was particularly engaged with Prof Grzybowski's findings, including the conundrum surrounding a lack of reported negative results. He noted that while several attempts to document negative results more thoroughly have been made in the scientific community, the lack of incentives, as well as the associated notoriety from reporting non-positive results, have proved to be a persistent problem. When discussing datasets and data augmentation, Prof Grzybowski cast some doubt on their value for generating reliable results as a larger strategy.

23.7 There were further discussions as to how results with dual-use or malicious implications should be reported in open literature, and Prof Grzybowski described some of the precautions taken by his research group, including blurring published structures relating to the so-called novichoks, and developing a website accessible only to those with government accreditation. The Board also discussed how these types of results should be dealt with on a regulatory level, nationally and internationally. Lastly, consideration was also given to the implications of supply chain rerouting and optimisation.

24. AGENDA ITEM TWENTY-FOUR – SAB discussion on the impact of AI and other emerging technologies

24.1 The SAB took the time to specifically discuss AI and associated emerging technologies with a view to identifying tangible actions that it might take or propose to the Director-General. Members generally agreed that a more in-depth review of the way AI is impacting chemistry and emerging technology relevant to the Convention would be beneficial in this regard. A TWG focused on AI is one potentially useful way of acquiring a deeper understanding of the subject, although members agreed that the TWG's terms of reference would be critical given the fast-moving development of AI

30 Agnieszka Wołos, Dominik Koszelewski, Rafał Roszak, Sara Szymkuć, Martyna Moskal, Ryszard Ostaszewski, Brenden Herrera, Josef Maier, Gordon Brezicki, Jonathon Samuel, Justin Lummiss, Tyler McQuade, Luke Rogers, and Bartosz Grzybowski. 2022. "Computer-Designed Repurposing of Chemical Wastes into Drugs." Nature 604 (7907): 668–76. doi.org/10.1038/s41586-022-04503-9.

31 Barbara Mikulak-Klucznik, Tomasz Klucznik, Wiktor Beker, Martyna Moskal, and Bartosz Grzybowski. 2024. "Catalyst: Curtailing the Scalable Supply of Fentanyl by Using Chemical AI." Chem 10(5): 1319-1326. doi.org/10.1016/j.chempr.2024.03.025.

and the myriad ways that it is impacting science and technology. The composition of the TWG should be such as to include a variety of scientific and technological disciplines in addition to AI expertise in order to ensure a diversity of views and an appropriate overview of the subject.

24.2 A discussion on the risks associated with AI and emerging technologies also generated some useful considerations. The SAB noted that in AI, a field that is maturing rapidly yet still poorly understood by many, better communication of risk and how to consider it would be useful to the Secretariat, States Parties, and chemical practitioners in general. This led to a broader discussion on how recommendations related to science and emerging technologies can be made to scientists and States Parties in order to avoid or minimise the risk of "dual use of the knowledge". The importance of communicating the limitations of AI was underscored. Even when AI is used to predict synthetic pathways and novel compounds for example, there are still a number of practical limitations, as well as a need for expertise and materials.

24.3 The Board discussed several additional ways in which the Organisation might gain a better understanding of AI, such as through the short-term secondment of technical experts, or by conducting a futures study, taking a holistic view of AI and the various ways in which its development might impact the work of the OPCW. With regard to technical experts, the idea of short-term secondments would allow the OPCW not to just gain expertise rapidly in terms of AI, but in any other emerging science or technology where it is important to gain a rapid understanding and increased expertise without devoting an entire recurring post to the specialty. This would give the Director-General greater flexibility in quickly responding to and preparing for the risks and benefits of emerging technologies.

25. AGENDA ITEM TWENTY-FIVE – SAB discussion on its approach to the Sixth Review Conference

25.1 The Board reviewed the overarching structure that formed the basis of its preparations for the SAB's report to the Fifth Review Conference, and members agreed that overall it remains relevant and applicable, and should therefore be retained in preparation for the Sixth Review Conference. It was proposed that, given the magnitude and wide-ranging impact of AI, this particular technology could be assigned a section of its own in the next report, and its role in enabling other areas of science and technology of relevance to the Convention could also be highlighted. Alternatively, ubiquitous technologies such as AI and nanotechnology could be discussed in broad terms in the preamble to the report, with specific examples highlighted in the relevant sections. There was general agreement that certain subtopics would fit better under different topic headings in the report. New subtopics, or existing ones that should be expanded, were discussed. These included, inter alia, organophosphate pesticides; sea-dumped chemical weapons; chemical safety and security in the context of extreme natural events and climate change; drones; biotoxin analysis; nanotechnology; and the challenges of hazardous chemical waste.

25.2 It was agreed that the information discussed would be captured as a mind map to visually represent the topics and subtopics, depicting the connections between them. This will form the basis of future discussions on the SAB's approach to the Sixth Review Conference.

26. AGENDA ITEM TWENTY-SIX – Update from SAB members on conferences and publications

26.1 The Board discussed publication of the SAB's report on developments in science and technology to the Fifth Review Conference in a yet-to-be-identified peer-reviewed journal. The SAB Chairperson emphasised that time is of the essence to ensure that the content of the publication remains current. While some preparatory work has already taken place, Mr Povoden requested assistance from two or three other SAB members in drafting the publication over the coming months.

26.2 The SAB Chairperson recalled the importance of publishing the work of the Board, which is an effective approach in sharing its robust scientific advice and increasing the visibility of the SAB, and ultimately of the OPCW. In the ensuing discussion, it was proposed that the findings of the TWG on the Analysis of Biotoxins could also be reformatted and prepared for publication.

26.3 As Italy currently holds the presidency of the Global Partnership Against the Spread of Weapons and Materials of Mass Destruction (the Global Partnership),[32] Dr Matteo Guidotti provided a brief overview of the Global Partnership Chemical Security Working Group meeting which took place on 8 February 2024 in Rome, Italy. He set out the composition and objectives of the Global Partnership, together with the priorities for the Italian presidency. Dr Guidotti focused the remainder of his briefing on the work of the Chemical Security Working Group. He reported that he co-chaired the meeting of this subgroup, which included participants from governmental institutions and international organisations, as well as experts in science and technology. Dr Guidotti highlighted specific presentations delivered on the dual-use of AI, origami paper-based biosensors for chemical warfare agents, and the impact of extreme natural events on chemical security.

26.4 Finally, Mr Povoden recounted his experience, as part of the Austrian armed forces, in the recovery, transport, storage, and disposal of two small cylinders of the Schedule 3 chemical phosgene. The cylinders, one of which was showing visible signs of corrosion, were discovered at a waste collection centre in Austria in March 2023. Under Austrian law, responsibility for any such chemicals, which are classified as materials of war, and which are found within the territory of Austria, falls to the military. The military is charged with the comprehensive management of these materials, including all aspects of risk assessment, security, transportation, storage, possible destruction, and decontamination.

26.5 To assist in bringing a criminal case against those responsible for disposing of the cylinders in a manner that could endanger life, the serial numbers on the cylinders were used for identification purposes, and the Austrian armed forces confirmed the identification of the contents, both in the field using phosgene Dräger tubes and mobile GC-MS, and subsequently in the laboratory. The military maintained the safe and secure intermediate storage of the cylinders pending the conclusion of the criminal proceedings and until approval for their disposal was received, which took more than one year.

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32 https://www.gpwmd.com/.

26.6 Final disposal took place on 20 April 2024, by which time both cylinders had become corroded from previous releases of phosgene. The disposal operation was planned in detail, and was informed by modelling the release plume, and the phosgene was successfully neutralised by reaction with 10% sodium hydroxide. A standard operating procedure for this process will be produced for future reference.

27. AGENDA ITEM TWENTY-SEVEN – SAB Chairperson and Vice-Chairperson election

The Board, with the assistance of the SAB Secretary, held a private meeting to elect its Chairperson and Vice-Chairperson for 2025. No interpretation was provided, and only Board members physically present were in attendance. Prof Imee Su Martinez was elected as Chairperson, and Prof Elisa Souza Orth was elected as Vice-Chairperson, by consensus, to serve in the next year.

28. AGENDA ITEM TWENTY-EIGHT – Any other business and closing remarks

28.1 The SAB Chairperson thanked the staff of the Secretariat and the interpretation team for their support at this successful session, and congratulated the newly elected Chairperson and Vice-Chairperson. He recalled that this was his last SAB meeting, as he will leave the Board at the end of 2024. He reaffirmed that he stands ready to support the Inspectorate in delivering its workshop on deployed equipment, and will remain a member of the TWG on Chemical Forensics. Finally, Mr Povoden thanked all the Board members for their participation in and contribution to the SAB's Thirty-Eighth Session.

28.2 The SAB is grateful to all States Parties, organisations, and institutions that have provided financial assistance to the work of the Board. In particular, it thanks the European Union, whose funding has made the work of the TWG on Chemical Forensics possible.

29. AGENDA ITEM TWENTY-NINE – Adoption of the report

The Board adopted the report of the session by consensus.

30. AGENDA ITEM THIRTY – Closure of the session

The Chairperson closed the Thirty-Eighth Session of the SAB at 15:47 CET on 31 May 2024.

Annex: List of Participants in the Thirty-Eighth Session of the Scientific Advisory Board

Annex

LIST OF PARTICIPANTS IN THE THIRTY-EIGHTH SESSION OF THE SCIENTIFIC ADVISORY BOARD

	Participant	Institution
Members of the Scientific Advisory Board		
1.	Dr Tareq AlAhmadi	King Fahd Security College, Saudi Arabia
2.	Dr Crister Åstot	Swedish Defence Research Agency (FOI), Sweden
3.	Dr Karim Ben Ali	Tunisian Military Research Center, Tunisia
4.	Capt Elma Biscotti	Scientific and Technical Research Institute for Defense (retired), Argentina
5.	Dr Anne Bossée	DGA CBRN Défense, France
6.	Dr Cindi Corbett	Public Health Agency of Canada's National Microbiology Laboratory (NML), Canada
7.	Mr Raza Ellahi	Defence Science & Technology Organization (DESTO), Pakistan
8.	Prof Mostafa Ghanei, MD	Baqiyatallah University of Medical Sciences, Iran (Islamic Republic of)
9.	Dr Norman Govan	Defence Science and Technology Laboratory, United Kingdom of Great Britain and Northern Ireland
10.	Prof Bartosz Grzybowski	Polish Academy of Sciences, Poland and Ulsan National Institute of Science and Technology (UNIST), Republic of Korea
11.	Dr Matteo Guidotti	Institute of Chemical Sciences and Technologies (SCITEC) of the Italian National Research Council, Italy
12.	Mr Wilford Jwalshik	Institute of Chartered Chemists, Nigeria
13.	Prof Victor Kholstov	Ministry of Industry and Trade, "GosNIIOKhT", Russian Federation
14.	Dr Andrea Leisewitz	University of San Sebastián, Chile
15.	Prof Imee Su Martinez (Vice-Chairperson)	University of the Philippines-Diliman, Philippines
16.	Dr Catharina Müller-Buschbaum	Accenture, Germany
17.	Prof Elisa Souza Orth	Federal University of Paraná, Brazil
18.	Dr Meehir Palit	Defence Research and Development Organisation, India
19.	Mr Günter Povoden (Chairperson)	CBRN Defence Centre, Ministry of Defence, Austria
20.	Prof Ines Primožič	University of Zagreb, Croatia
21.	Dr Moussa Sehailia	Scientific and Technical Research Centre in Physico-chemical Analysis (CRAPC), Algeria
22.	Prof Fengxia Sun	Hebei University of Science and Technology, China
23.	Prof Vessela Tsakova-Stancheva	Institute of Physical Chemistry at the Bulgarian Academy of Sciences, Bulgaria

	Participant	Institution
24.	Dr Normandla Magnificent Vela	Protechnik Laboratories, South Africa
Secretary to the Scientific Advisory Board		
25.	Dr Peter Hotchkiss	Organisation for the Prohibition of Chemical Weapons, Netherlands
Invited Speakers		
26.	Dr Gerald Bauer	Austrian Federal Ministry of Defence, Austria
27.	Dr Ildefonso CamposVelarde	Organisation for the Prohibition of Chemical Weapons, Netherlands
28.	Dr Davin Carter	Organisation for the Prohibition of Chemical Weapons, Netherlands
29.	Prof Omar Farha	Northwestern University, United States of America
30.	Prof Steve Li	Auburn University, United States of America
31.	Mr Adriaan Marais	Organisation for the Prohibition of Chemical Weapons, Netherlands
32.	Mr Keegan McGrath	Organisation for the Prohibition of Chemical Weapons, Netherlands
33.	Ms Helen Mearns	U.S. Department of Homeland Security, United States of America
34.	Prof Tim Noël	University of Amsterdam, Netherlands
35.	Mr Cormac O'Reilly	Organisation for the Prohibition of Chemical Weapons, Netherlands
36.	Ms Luisa Sánchez-Bravo	Organisation for the Prohibition of Chemical Weapons, Netherlands
37.	Dr Raja Subramaniam	National Authority for Chemical Weapons Analysis, Malaysia
38.	Prof David Wishart	University of Alberta, Canada
39.	Dr Ardalan Zargham	Organisation for the Prohibition of Chemical Weapons, Netherlands
40.	Dr Sergey Zinoviev	Organisation for the Prohibition of Chemical Weapons, Netherlands

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