

**SUMMARY OF THE SECOND MEETING OF THE SCIENTIFIC ADVISORY  
BOARD'S TEMPORARY WORKING GROUP  
ON INVESTIGATIVE SCIENCE AND TECHNOLOGY****1. AGENDA ITEM ONE – Opening of the meeting**

- 1.1 The Scientific Advisory Board's (SAB) Temporary Working Group (TWG) on Investigative Science and Technology held its Second Meeting from 14 to 16 November 2018 at OPCW Headquarters in The Hague. The meeting was chaired by Dr Veronica Borrett on behalf of the SAB, with support from Vice-Chairperson Dr Ed van Zalen.
- 1.2 Dr Borrett opened the meeting by reiterating the TWG's objectives.<sup>1</sup> She thanked the TWG members for their intersessional work, as well as the invited speakers, who had kindly given their time to support the meeting. Dr Borrett outlined the process for reviewing progress on the questions summarised in the TWG's terms of reference (TOR)<sup>1</sup> and also the efforts to explore new and emerging technologies or approaches relevant to investigations mandated under Articles IX and X of the Chemical Weapons Convention (hereinafter "the Convention"). In addition to engagement with forensic experts on best practices for investigation, she highlighted the importance of engagement with experts from the Technical Secretariat (hereinafter "the Secretariat") and the Designated Laboratories (DLs), to ensure that TWG advice is guided by the needs and experience of those carrying out the investigative work. Dr Borrett thanked the Secretariat, on behalf of the TWG, for its contributions.

**Executive Summary**

- 1.3 At its Second Meeting, the TWG on Investigative Science and Technology received briefings on the Secretariat's fact-finding and investigatory activities. These briefings provided important background for the Group's consideration of the needs of the Secretariat, and equipment and procedures that could help strengthen the Secretariat's capabilities.

---

<sup>1</sup>

For the terms of reference, see Annex 1 of "Summary of the First Meeting of the Scientific Advisory Board's Temporary Working Group on Investigative Science and Technology" (SAB-27/WP.1, dated 26 February 2018) [www.opcw.org/sites/default/files/documents/SAB/en/sab-27-wp01\\_e.pdf](http://www.opcw.org/sites/default/files/documents/SAB/en/sab-27-wp01_e.pdf). A quick reference guide to the questions contained within the Terms of Reference is available at: [www.opcw.org/sites/default/files/documents/SAB/en/TWG\\_Investigative\\_Science\\_Tech\\_Questions.pdf](http://www.opcw.org/sites/default/files/documents/SAB/en/TWG_Investigative_Science_Tech_Questions.pdf).



- 1.4 The TWG was also briefed by invited experts on the following areas:
- (a) forensic and investigative capabilities that are in use or being developed, including methods for detecting concealment or tampering with digital information, remote sampling using unmanned ground and aerial vehicle platforms, and the usage of satellite imagery for retrospective analysis and proactive monitoring;
  - (b) chemical and biomarker analysis, including methods for identifying injury due to chlorine exposure; and
  - (c) investigation of recent terrorism incidents in Germany and the United Kingdom of Great Britain and Northern Ireland.
- 1.5 The sub-groups established at the first TWG meeting updated the group on their findings. In general, each sub-group has identified specific areas for further discussion. The TWG intends to hold three additional meetings in 2019 to enable a substantive report, including recommendations, to be finalised before the Group's mandate ends in February 2020.
- 1.6 The TWG notes that it is already apparent that when undertaking investigative activities, OPCW inspection teams could benefit from having a "forensic advisor" within the team and/or available to advise from off-site for planning and carrying out investigative activities to help ensure that they meet international forensic standards, take advantage of modern forensic methods, and tap into the broad range of forensic expertise that is available (see paragraph 14.3). Furthermore, establishing working relationships in advance with forensic science organisations, laboratories, and experts is important to ensure that the Secretariat has a network that can provide advice and analytical services on short notice (see paragraphs 14.4 to 14.6). The TWG suggests that the SAB consider developing advice to the Director-General on these two aspects in the near future.

## 2. AGENDA ITEM TWO – Adoption of the agenda

The TWG **adopted** the following agenda for its Second Meeting:

1. Opening of the Meeting
2. Adoption of the agenda
3. *Tour de table* to introduce temporary working group members, observers, and guest speakers
4. Establishment of a drafting committee
5. Remarks from OPCW Director-General
6. Fourth Special Conference of the States Parties, outcome and implications
7. Inspectorate operations and contingency planning
  - (a) Capacity building for contingency operations

- (b) The OPCW Situation Centre
- 8. Declarations Assessment Team (DAT)
- 9. OPCW and Designated Laboratories
  - (a) OPCW Laboratory updates
  - (b) Chemical attribution methodologies
- 10. Assistance and protection: chemical forensics and evidence management
- 11. Engagement with external experts
  - (a) ICC Scientific Advisory Board
  - (b) ANZFSS 24th International Symposium on the Forensic Sciences
  - (c) Chemical Forensics International Technical Working Group (CFITWG)
- 12. Forensic and investigative science
  - (a) Digital evidence concealment and tampering
  - (b) Remote sampling based on unmanned ground and aerial vehicle platforms: intermediate results and way ahead of the European Defence Agency Improvised Explosive Device Detection Programme
  - (c) Use of satellite imagery for retrospective analysis and proactive monitoring
  - (d) Corruption of knowledge in the authentication of reference materials: chemical weapons and art attribution
- 13. Chemical and biomarker analysis
  - (a) Chlorine analysis
  - (b) Chlorine inhalation injury: targets, biomarkers, and countermeasures
  - (c) Waste water epidemiology
- 14. Sub-group updates and discussion
- 15. Recent incidents
  - (a) A thwarted bioterrorism event in Cologne, Germany
  - (b) OPCW Technical Assistance Visits (TAVs)
  - (c) Related work of the Scientific Advisory Board
- 16. Next steps, agendas, and dates for meetings in 2019

17. Drafting and adoption of the report

18. Closure of the meeting

**3. AGENDA ITEM THREE – *Tour de table* to introduce Temporary Working Group members, observers, and guest speakers**

A *tour de table* was undertaken to introduce the TWG members, observers, and guest speakers. A list of participants appears in Annex 1 of this report.

**4. AGENDA ITEM FOUR – Establishment of a drafting committee**

The TWG established a drafting committee to prepare the draft report of its Second Meeting.

**5. AGENDA ITEM FIVE – Remarks from the Director-General**

5.1 H. E. Ambassador Fernando Arias delivered the welcome address, as his first opportunity to meet with members of the SAB since assuming office as the OPCW Director-General this past July.<sup>2</sup> The Director-General expressed concerns about uncertainties and challenges in today's security environment and emphasised the need for sound scientific advice in achieving the objectives of the Convention. In this regard, he acknowledged the contributions of the SAB, and especially its report to the Fourth Review Conference,<sup>3,4</sup> and he called on the TWG to continue to build on this advice.

5.2 Turning to the decision on addressing the threat from chemical weapons use,<sup>5</sup> taken by the Conference of States Parties (hereinafter "the Conference") at a special session held in June 2018,<sup>6</sup> the Director-General informed the TWG that the OPCW has now been asked to identify perpetrators of chemical weapons use in the Syrian Arab Republic (SAR). He noted the relevance of the work of the TWG and explained that identification of perpetrators is one step in a process to hold to account those breaking the global norm against using chemical weapons. The process requires a broad range

---

<sup>2</sup> OPCW News Item, 25 July 2018, "*Ambassador Fernando Arias Assumes Office as OPCW Director-General*", [www.opcw.org/media-centre/news/2018/07/ambassador-fernando-arias-assumes-office-opcw-director-general](http://www.opcw.org/media-centre/news/2018/07/ambassador-fernando-arias-assumes-office-opcw-director-general).

<sup>3</sup> Fourth Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention; [www.opcw.org/rc-4](http://www.opcw.org/rc-4).

<sup>4</sup> (a) "Report of the Scientific Advisory Board on Developments in Science and Technology for the Fourth Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention" (RC-4/DG.1, dated 30 April 2018); [www.opcw.org/sites/default/files/documents/CSP/RC-4/en/rc4dg01\\_e.pdf](http://www.opcw.org/sites/default/files/documents/CSP/RC-4/en/rc4dg01_e.pdf). (b) See also, "Response by the Director-General to the Report of the Scientific Advisory Board on Developments in Science and Technology for the Fourth Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention" (RC-4/DG.2, dated 1 June 2018); [www.opcw.org/sites/default/files/documents/CSP/RC-4/en/rc4dg02\\_e.pdf](http://www.opcw.org/sites/default/files/documents/CSP/RC-4/en/rc4dg02_e.pdf).

<sup>5</sup> "Decision: Addressing the Threat from Chemical Weapons Use" (C-SS-4/DEC.3, dated 27 June 2018); [www.opcw.org/sites/default/files/documents/CSP/C-SS-4/en/css4dec3\\_e.doc.pdf](http://www.opcw.org/sites/default/files/documents/CSP/C-SS-4/en/css4dec3_e.doc.pdf).

<sup>6</sup> Fourth Special Session of the Conference of the States Parties, held from 26 to 27 June 2018; [www.opcw.org/resources/documents/conference-states-parties/csp-ss-4](http://www.opcw.org/resources/documents/conference-states-parties/csp-ss-4).

of institutions and mechanisms working in unison, with the OPCW playing one part. He added such missions bring increased levels of international scrutiny, demanding that all scientific findings stand on their technical merit and be objective, accurate, and incontrovertible.

- 5.3 The Director-General asked the TWG to challenge assumptions and consider the non-routine operating environments of OPCW missions involving chemical weapon use in their discussions. He stressed that communication of key scientific and technical insights from the TWG (and the SAB on broader issues) is critical to ensure decision makers are fully informed on the key technical dimensions of the issues they face.

**6. AGENDA ITEM SIX – Fourth Special Conference of the States Parties, outcome and implications**

- 6.1 Ms Veronika Stromsikova (Director of the Office of Strategy and Policy) briefed the TWG on the decision, C-SS-4/DEC.3, “Addressing the Threat from Chemical Weapons”.<sup>5</sup> This decision instructs the Secretariat to put in place arrangements to identify perpetrators of the use of chemical weapons in the SAR by identifying and reporting on all information potentially relevant to the origin of those chemical weapons in instances for which the OPCW Fact-Finding Mission (FFM)<sup>7</sup> determines or has determined that use or likely use occurred, as well as cases for which the OPCW-United Nations Joint Investigative Mechanism (JIM) did not issue a report.<sup>8</sup>
- 6.2 The Secretariat is establishing a team to implement activities related to the identification of perpetrators in an impartial and objective manner. The Secretariat is

---

<sup>7</sup> (a) “Summary Update of the Activities Carried out by the OPCW Fact-Finding Mission in Syria” (S/1677/2018, dated 10 October 2018); [www.opcw.org/sites/default/files/documents/2018/10/s-1677-2018%28e%29.pdf](http://www.opcw.org/sites/default/files/documents/2018/10/s-1677-2018%28e%29.pdf). (b) For further information on the Fact-Finding Mission, see: [www.opcw.org/fact-finding-mission](http://www.opcw.org/fact-finding-mission).

<sup>8</sup> The JIM produced seven reports from Reports from 2016 – 2017. Six are publicly available: (a) “First report of the Organisation for the Prohibition of Chemical Weapons United Nations Joint Investigative Mechanism” (UNSC, S/2016/142, dated 12 February 2016); <http://undocs.org/S/2016/142>; (b) “Third report of the Organisation for the Prohibition of Chemical Weapons-United Nations Joint Investigative Mechanism” (UNSC, S/2016/738, dated 24 August 2016); <http://undocs.org/S/2016/738>; (c) “Fourth report of the Organisation for the Prohibition of Chemical Weapons-United Nations Joint Investigative Mechanism” (UNSC, S/2016/888, dated 21 October 2016); <http://undocs.org/S/2016/888>; (d) “Fifth report of the Organisation for the Prohibition of Chemical Weapons-United Nations Joint Investigative Mechanism” (UNSC, S/2017/131, dated 13 February 2017); <http://undocs.org/S/2017/131>; (e) “Sixth report of the Organisation for the Prohibition of Chemical Weapons-United Nations Joint Investigative Mechanism” (UNSC, S/2017/552, dated 28 June 2017); <http://undocs.org/S/2017/552>; and (f) “Seventh report of the Organisation for the Prohibition of Chemical Weapons-United Nations Joint Investigative Mechanism” (UNSC, S/2017/904, dated 26 October 2017); <http://undocs.org/S/2017/904>.

also developing proposals to take the decision forward,<sup>9</sup> which includes proposals aimed at strengthening the implementation of the Convention and supporting States Parties in key areas related to the verification regime, national implementation, chemical security, international cooperation, and preventing and responding to threats of the use of chemical weapons by non-State actors.<sup>10</sup> States Parties are currently considering these proposals in effort to fund, establish, and implement arrangements related to C-SS-4/DEC.3. Ms Stromsikova discussed the genesis, mission, and contours of actions arising from C-SS-4/DEC.3.

6.3 In the subsequent discussion, the following points were raised:

- (a) Identification of perpetrators is only one part in a process to hold to account perpetrators of the use of chemical weapons. The mission for identification of perpetrators does not impart judicial or law enforcement powers to the OPCW.
- (b) External engagement might play an important role in developing the Secretariat's capability to fulfil the mission of C-SS-4/DEC.3. This might come through formal memorandums of understanding with relevant forensic partners. Sharing and/or exchange of information relevant to a given investigation would be a key aspect of any such agreement, while fully respecting any applicable confidentiality rules.
- (c) A role for DLs in the identification of perpetrators was discussed. If identification is pursued based on the Decision, this would be after a determination by the FFM, where the DLs may already have analysed samples. If further chemical analysis is required, DLs may be needed. However, if forensic analysis is required, laboratories with appropriate forensic expertise will need to be accessed. Consideration of the development of a network of forensic laboratories that can be called upon as needed could be helpful in this regard.
- (d) The TWG can play a role in identifying organisations that can provide access to relevant capabilities on request. In addition, the mandate of the TWG was drafted before C-SS-4/DEC.3. As implementation progresses, the questions tasked to the TWG might be reviewed and modified to fulfil the needs of the OPCW's investigative work. Continued dialogue with the Secretariat and the TWG will be needed to identify where the TWG's advice is most beneficial.

---

<sup>9</sup>

(a) "Report Pursuant to Paragraph 20 Of Decision C-SS-4/DEC.3 (Dated 27 June 2018) on Addressing the Threat From Chemical Weapons Use" (C-23/DG.17, dated 15 November 2018); [www.opcw.org/sites/default/files/documents/2018/11/c23dg17%28e%29.pdf](http://www.opcw.org/sites/default/files/documents/2018/11/c23dg17%28e%29.pdf). (b) "Report on Proposals and Options Pursuant to Paragraph 21 Of Decision C-SS-4/DEC.3 (Dated 27 June 2018) on Addressing the Threat From Chemical Weapons Use" (C-23/DG.16 - RC-4/DG.4, dated 15 November 2018); [www.opcw.org/sites/default/files/documents/2018/11/c23dg16%20rc4dg04%28e%29.pdf](http://www.opcw.org/sites/default/files/documents/2018/11/c23dg16%20rc4dg04%28e%29.pdf). (c) "Progress in the Implementation of Decision C-SS-4/DEC.3 on Addressing the Threat from Chemical Weapons Use" (EC-89/DG.29, dated 4 October 2018). (d) "Initial Implementation of Decision C-SS-4/DEC.3 on Addressing the Threat from Chemical Weapons Use" (EC-89/EG.2, dated 27 July 2018).

<sup>10</sup>

"Report on Proposals and Options Pursuant to Paragraph 21 Of Decision C-SS-4/DEC.3 (Dated 27 June 2018) on Addressing the Threat From Chemical Weapons Use" (C-23/DG.16 - RC-4/DG.4, dated 15 November 2018); [www.opcw.org/sites/default/files/documents/2018/11/c23dg16%20rc4dg04%28e%29.pdf](http://www.opcw.org/sites/default/files/documents/2018/11/c23dg16%20rc4dg04%28e%29.pdf).

- (e) The provision of paragraph 20 of C-SS-4/DEC.3 allows States Parties to request assistance from the Secretariat in identifying perpetrators. This could potentially be through providing support to an investigation or possibly the Secretariat being asked to participate in an investigation. If and how the Secretariat responds would need to be evaluated by the OPCW for each specific case. The legal complexities that may be involved in a domestic criminal prosecution would need to be carefully considered.

## 7. AGENDA ITEM SEVEN – Inspectorate operations and contingency planning

### Subitem 7(a): Capacity building for contingency operations

- 7.1 Dr Michael Hoefler (Head, Inspectorate Capacity Building and Contingency Operations Cell) briefed the TWG on the efforts of the Inspectorate to prepare for contingency operations and non-routine missions. He noted that since 2013,<sup>11</sup> with the confirmation of the use of chemical weapons in the Syrian Arab Republic,<sup>12</sup> the subsequent accession of the Syrian Arab Republic to the Convention,<sup>13</sup> and the confirmation of the use of chemical weapons in Iraq,<sup>14</sup> the mission portfolio of OPCW's Inspectorate has expanded. The FFM,<sup>7</sup> technical assistance visits (TAVs),<sup>15,16</sup> and missions to the Syrian Scientific Studies and Research Centre (SSRC)<sup>17</sup> do not fall under the provisions for investigations of alleged use (IAUs) or

---

<sup>11</sup> For a review of the changes that have occurred in the implementation of the Convention since 2013, see: "Review of the Operation of the Chemical Weapons Convention since the Third Review Conference" (RC-4/S/1, dated 6 November 2018); [www.opcw.org/sites/default/files/documents/2018/11/rc4s01%28e%29.pdf](http://www.opcw.org/sites/default/files/documents/2018/11/rc4s01%28e%29.pdf).

<sup>12</sup> "United Nations Mission to Investigate Allegations of the Use of Chemical Weapons in the Syrian Arab Republic" (UNSC, A/68/663-S/2013/735, dated 13 December 2013); <https://undocs.org/A/68/663>.

<sup>13</sup> Information related to activities of OPCW in the Syrian Arab Republic is available at: [www.opcw.org/media-centre/featured-topics/syria-and-opcw](http://www.opcw.org/media-centre/featured-topics/syria-and-opcw).

<sup>14</sup> See paragraph 1.10 of "Report of the OPCW on the Implementation of the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction in 2016" (C-22/4, dated 29 November 2017); [www.opcw.org/sites/default/files/documents/CSP/C-22/en/c2204\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/CSP/C-22/en/c2204_e_.pdf).

<sup>15</sup> For recent TAVs to the Syrian Arab Republic, see: "Report on the Special Mission Conducted in Response to the Requests and Information Received from the Syrian Arab Republic Through Notes Verbales Dated 6, 16, and 20 November 2017; 28 December 2017; and 8 and 22 January 2018" (S/1596/2018, dated 2 March 2018).

<sup>16</sup> For Recent TAVs to the United Kingdom of Great Britain and Northern Ireland, see: (a) "Summary of the Report on Activities Carried Out in Support of a Request for Technical Assistance by the UK (Technical Assistance Visit TAV/03/18 and TAV/03B/18, "Amesbury Incident")" (S/1671/2018, dated 4 September 2018); [www.opcw.org/sites/default/files/documents/S\\_series/2018/en/s-1671-2018\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/S_series/2018/en/s-1671-2018_e_.pdf). (b) "Summary of the Report on Activities Carried Out in Support of a Request for Technical Assistance by the United Kingdom of Great Britain and Northern Ireland (Technical Assistance Visit TAV/02/18)" (S/1612/2018, dated 12 April 2018); [www.opcw.org/sites/default/files/documents/S\\_series/2018/en/s-1612-2018\\_e\\_1\\_.pdf](http://www.opcw.org/sites/default/files/documents/S_series/2018/en/s-1612-2018_e_1_.pdf).

<sup>17</sup> (a) "Status of Implementation of Executive Council Decision EC-83/DEC.5 (dated 11 November 2016)" (EC-87/DG.15, dated 23 February 2018; and EC-87/DG.15/Add.1, dated 28 February 2018). (b) "First Inspections at the Barzah and Jamrayah Syrian Scientific Studies and Research Centre Facilities in Syrian Arab Republic in Accordance with Decision EC-83/DEC.5 (dated 11 November 2016)" (EC-85/DG.16, dated 2 June 2017). (c) "Status of Implementation of Executive Council Decision EC-83/DEC.5 (dated 11 November 2016)" (EC-84/DG.25, dated 6 March 2017); [www.opcw.org/sites/default/files/documents/EC/84/en/ec84dg25\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/EC/84/en/ec84dg25_e_.pdf).

challenge inspections (CIs) in Articles IX and X of the Convention,<sup>18</sup> yet their objectives can contain similar aspects. The recent decision C-SS-4/DEC.3 brings an additional obligations to factor into current and future mission statements. This identification of perpetrators capacity has not previously existed within the Secretariat, although FFMs have provided the technical starting point for the work performed by the JIM.<sup>8</sup>

- 7.2 Dr Hoefler noted that the non-routine missions expose inspectors to a diversity of circumstances, often requiring in the field improvisation. Immediate mission related needs, however, limit the availability of resources for training and capability development for possible scenarios of future non-routine scenarios. Dr Hoefler explained that while training is coordinated and planned through the Capacity Building and Contingency Planning Cell within the Inspectorate, the capacity building encompasses more than simply training inspectors. Backgrounds and profiles of key team members, designing fit-for-purpose team composition, and the need to keep abreast of new technologies to improve operational capability must all be considered under capacity building.
- 7.3 Dr Hoefler explained that if a mission profile follows a standard path, experienced team leaders can perform non-routine missions in a field tried and tested manner. When faced with unfamiliar scenarios, however, a number of issues (described in the sub-paragraphs below) must be considered. Dr Hoefler encouraged the TWG to consider these points in their discussions.
- (a) There is a need for continually adapting long-term planning to changing operational and political environments, as these can have significant impact on the capacity building of deployable teams.
  - (b) Previously unanticipated mission scenarios are often handled in a case by case manner, as there are not pre-existing functional units that meet the specific needs of the mission. Pre-existing deployable teams, prepared for a variety of possible future scenarios, could enhance mission effectiveness and be less prone to disruption by staff turnover.
  - (c) New non-routine missions with objectives that differ from previous contingency missions should be expected from C-SS-4/DEC.3. However, without suitable adjustment of staffing and funding, there could be impact on what can be accomplished.
  - (d) A scenario-based study to develop a priority list of possible future scenarios involving the OPCW with a ranking of likelihood to occur would support planning.
  - (e) Lessons-learned processes are needed for all non-routine missions, to improve mission performance, and capture crucial knowledge and experience.
  - (f) Experienced team leaders and inspectors are best suited to help in the development of capabilities for new and less experienced inspectors. The need

---

<sup>18</sup> “Three Types of Inspections, OPCW Fact Sheet Number 5” (2017); [www.opcw.org/sites/default/files/documents/Fact\\_Sheets/English/Fact\\_Sheet\\_5\\_-\\_Inspections.pdf](http://www.opcw.org/sites/default/files/documents/Fact_Sheets/English/Fact_Sheet_5_-_Inspections.pdf).



for finding and following best practices and procedures for the transfer of skills and knowledge (pairing of experienced and new staff members under operational conditions, for example) cannot be overstated.

7.4 In the subsequent discussion, the following points were raised:

- (a) The Secretariat is required to be prepared to conduct CIs and IAUs,<sup>19</sup> missions that follow defined procedures within the Convention. The types of non-routine missions discussed by Dr Hoefer have required flexibility and on the job learning. The development and assessment of a set of scenarios that can be ranked for likelihood could help training and preparation of inspection teams.
- (b) Developing scenarios and their risk assessment requires outside input. There may also be lessons to learn from the experiences of disaster relief and response involving large-scale chemical accidents and exposures. The TWG might consider how the Secretariat might approach relevant communities.
- (c) In preparing for potential future non-routine missions, the DLs may have a role to play in enhancing the ability to respond to questions from the field, performing follow-up analysis of samples as new information is considered. They may also support preparation for incidents involving unscheduled chemicals, including toxic industrial chemicals determined to pose a high risk for use as a weapon by non-state actors.
- (d) When analysing information, using the results of investigative and forensic analysis to find linkages and correlations across multiple investigations (not just looking at isolated analyses of a single sample or a single investigation) is an important capability to develop. This “forensic intelligence” approach allows recognition of similar patterns across diverse events and streams of data, allowing retrospective and prospective analytical outputs.<sup>20</sup>

#### **Subitem 7(b): The OPCW Situation Centre**

7.5 Mr Leo Buzzerio (Senior Communications and Information Officer, Inspectorate Operations and Administration Branch) presented an overview of the OPCW Situation Centre. He began with the mission and organisation of the Situation Centre

---

<sup>19</sup> “Update on the Technical Secretariat's Readiness to Conduct a Challenge Inspection or an Investigation of Alleged Use” (EC-88/DG.19, dated 29 June 2018); [www.opcw.org/sites/default/files/documents/EC/88/en/ec88dg19\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/EC/88/en/ec88dg19_e_.pdf).

<sup>20</sup> (a) F. Crispino, Q. Rossy, O. Ribaux, C. Roux; Education and training in forensic intelligence: a new challenge, *Australian Journal of Forensic Sciences*, 2016, 47(1), 49-60. DOI: 10.1080/00450618.2014.906655 (b) Forensic intelligence framework. part II: study of the main generic building blocks and challenges through the examples of illicit drugs and false identity documents monitoring, S. Baechler, M. Morelato, O. Ribaux, A. Beavis, M. Tahtouh, K. P. Kirkbride, P. Esseiva, P. Margot, C. Roux; *Forensic Science International*, 2015, 250, 44-52. (c) Forensic intelligence framework - part I: induction of a transversal model by comparing illicit drugs and false identity documents monitoring, M. Morelato, S. Baechler, O. Ribaux, A. Beavis, M. Tahtouh, P. Kirkbride, C. Roux, P. Margot; *Forensic Science International* 2014, 236, 181-190. (d) Integrating forensic information in a crime intelligence database; Q. Rossy, S. Ioset, D. Dessimoz, O. Ribaux, *Forensic Sci. Int.*, 2013, 230(1-3), 137-146. DOI: 10.1016/j.forsciint.2012.10.010.

and discussed the transformation of the previous Operations Centre to a Situation Centre. The Situation Centre is designed to provide 24 hour mission support, develop and maintain a comprehensive operating picture, ensure secure and reliable communications, and provide information analysis to facilitate senior management decision making. Mr Buzzerio described how the Situation Centre ensures communications with States Parties and deployed inspection teams, monitors routine and non-routine missions, and conducts analytical activities and provides support to FFM investigations. Mr. Buzzerio described the Situation Centre's open-source information analysis capabilities, presenting examples of information analysis carried out in support of FFM activities in the Syrian Arab Republic related to Al-Hamadaniyah in 2016,<sup>21</sup> Khan Shaykhun in 2017,<sup>22</sup> and Douma in 2018.<sup>23</sup>

7.6 In the subsequent discussion, the potential for gathering and integrating other information streams was raised. This could include the tracking of chemical sales and transfers (or transfers of a collective set of chemicals) that might be indicative of preparation of a chemical weapon.<sup>24</sup>

## 8. AGENDA ITEM EIGHT – Declarations Assessment Team (DAT)

8.1 Mr Nihad Alihodzic (Head, OPCW Declarations Assessment Team) updated the TWG on the ongoing work of the Declarations Assessment Team (DAT).<sup>25</sup> Drawing on lessons learned, he presented the TWG with a series of scenarios where gaps, discrepancies, and inconsistencies in information and analysis might be encountered in an investigation. He encouraged the TWG to think about enabling capabilities that could benefit the Secretariat in future chemical weapon programme related verification missions.

8.2 In the subsequent discussion, the following points were raised:

(a) When working in non-permissive environments, the ability to collect the greatest amount of information in a limited timeframe is valuable. Particularly

---

<sup>21</sup> “Report of the OPCW Fact-Finding Mission in Syria Regarding the Incidents in Al-Hamadaniyah on 30 October 2016 and in Karm Al-Tarrab on 13 November 2016” (S/1642/2018, dated 2 July 2018). [www.opcw.org/sites/default/files/documents/S\\_series/2018/en/s-1642-2018\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/S_series/2018/en/s-1642-2018_e_.pdf),

<sup>22</sup> (a) “Further Clarifications why the OPCW Fact-Finding Mission did not Deploy to Khan Shaykhun” (S/1545/2017, dated 17 October 2017). (b) “Analysis Results of The Samples Provided by the Government of the Syrian Arab Republic in Relation to the Alleged Incident in Khan Shaykhun, Syrian Arab Republic, April 2017” (S/1521/2017, dated 28 July 2017). (c) “Report of the OPCW Fact-Finding Mission in Syria regarding an alleged incident in Khan Shaykhun, Syrian Arab Republic April 2017” (S/1510/2017, dated 29 June 2017). Available at: [www.opcw.org/sites/default/files/documents/Fact\\_Finding\\_Mission/s-1510-2017\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/Fact_Finding_Mission/s-1510-2017_e_.pdf). (d) “Status Update of the OPCW Fact-Finding Mission in Syria Regarding a Reported Incident in Khan Shaykhun, 4 April 2017” (S/1497/2017, dated 12 May 2017); [www.opcw.org/sites/default/files/documents/Fact\\_Finding\\_Mission/s-1497-2017\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/Fact_Finding_Mission/s-1497-2017_e_.pdf).

<sup>23</sup> “Interim Report of the OPCW Fact-Finding Mission in Syria Regarding the Incident of Alleged Use of Toxic Chemicals as a Weapon in Douma, Syrian Arab Republic, on 7 April 2018” (S/1645/2018, dated 6 July 2018, and corrigendum dated 10 July 2018); [www.opcw.org/sites/default/files/documents/S\\_series/2018/en/s-1645-2018\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/S_series/2018/en/s-1645-2018_e_.pdf).

<sup>24</sup> Networks for Organic Reactions and Compounds, B. A. Grzybowski, K. J. M. Bishop, B. Kowatczyk, C. E. Wilmer; US Patent Application US20180276346A1, 2018.

<sup>25</sup> For further information on the DAT, see: [www.opcw.org/declaration-assessment-team](http://www.opcw.org/declaration-assessment-team).

important is the ability to collect information that can be respectively analysed and integrated with other data sets. Capturing 3D models of infrastructure and investigation sites was discussed as a potential solution, especially if there is a possibility that an investigation site might be destroyed after an initial visit, allowing only what had been obtained in the initial visit to remain available for further review. The ability to have evidence that can be accessed retrospectively was viewed as a safeguard to aid detection of potential tampering of evidence in its subsequent recording.

- (b) The application of forensic intelligence approaches to help link information across multiple sites and time points was also seen as valuable for retrospectively evaluating a chemical weapons programme.
- (c) In the verification of production and disposal of chemicals, analysis of the disposal sites may be required. A greater range of sampling methods and an understanding of the environmental fate, including transformations brought about by burning or other means of destruction could provide relevant information. The techniques used in arson investigations to identify the fuels used to start fires, for example, could be of value if looking to verify information related to destruction of chemicals by burning.
- (d) The TWG noted that a mission such as the DAT can be hampered by a variety of practical problems that may limit the ability to collect and evaluate materials and information. These issues are not always visible to decision makers reviewing final reports. Finding efficient ways to convey these issues to delegations to provide insights into mission constraints that lead to given outcome is something to consider.

## 9. AGENDA ITEM NINE – OPCW and Designated Laboratories<sup>26</sup>

### Subitem 9(a): Update from the OPCW Laboratory

- 9.1 Dr Marc-Michael Blum (Head, OPCW Laboratory) updated the TWG on the OPCW Laboratory enhancement project.<sup>27</sup> The project is moving forward. In 2018, voluntary

---

<sup>26</sup> OPCW Designated Laboratories as of 29 August 2018 (a) “Status of Laboratories Designated for Analysis of Authentic Environmental Samples” (S/1666/2018, dated 29 August 2018); [www.opcw.org/sites/default/files/documents/2018/08/s-1666-2018%28e%29.pdf](http://www.opcw.org/sites/default/files/documents/2018/08/s-1666-2018%28e%29.pdf). (b) “Status of the Laboratories Designated for the Analysis of Authentic Biomedical Samples” (S/1661/2018, dated 14 August 2018); [www.opcw.org/sites/default/files/documents/2018/08/s-1661-2018%28e%29.pdf](http://www.opcw.org/sites/default/files/documents/2018/08/s-1661-2018%28e%29.pdf).

<sup>27</sup> (a) “Request from the Director-General to States Parties for Voluntary Contributions to a New Trust Fund for Upgrading the OPCW Chemical Laboratory to a Centre for Chemistry and Technology” (S/1561/2017, dated 8 December 2017); [www.opcw.org/sites/default/files/documents/S\\_series/2017/en/s-1561-2017\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/S_series/2017/en/s-1561-2017_e_.pdf) (b) “Upgrading the OPCW Chemical Laboratory to a Centre for Chemistry and Technology” (S/1512/2017, dated 10 July 2017); [www.opcw.org/sites/default/files/documents/S\\_series/2017/en/s-1512-2017\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/S_series/2017/en/s-1512-2017_e_.pdf). (c) “Needs Statement for Upgrading the OPCW Chemical Laboratory to a Centre for Chemistry and Technology” (S/1564/2017, dated 22 December 2017); [www.opcw.org/sites/default/files/documents/S\\_series/2017/en/s-1564-2017\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/S_series/2017/en/s-1564-2017_e_.pdf).

contributions were received from Belgium,<sup>28</sup> Canada,<sup>29</sup> Poland,<sup>30</sup> and the Republic of Korea, while the Netherlands provided support for acquisition of an identified plot. Announcements of intention to contribute have also come from Estonia and the United Kingdom of Great Britain and Northern Ireland.

9.2 In the subsequent discussion, the following points were raised:

- (a) Incorporating forensic processes into current capabilities would be a valuable addition to the capabilities of the OPCW laboratory.
- (b) Questions were raised on whether the laboratory could be prepared in future to handle samples that contained chemical and radiological materials and/or chemical and biological materials, and what the best approaches are toward these types of combined contaminated samples. Dr Daan Noort intends to brief the TWG on this issue at a future meeting.

### **Subitem 9(b): Chemical Attribution Methodologies**

9.3 Ms Hoe-Chee Chua (member of the SAB, guest speaker) provided an overview of methodologies being reviewed at the DSO National Laboratory<sup>31</sup> for application to chemical attribution (CA). Method development in this area has gained considerable attention due to recent events involving the use of chemical agents and the potential need for incorporating CA into the workflow of DLs.

9.4 Impurity profiling and stable isotope ratio determination are potential methodologies considered for the collection of chemical forensics (CF) signatures. Impurity profiling can be achieved through the DLs' existing suite of instrumentation, including mass spectrometry (MS) techniques coupled with gas or liquid chromatography (GC, LC).<sup>32</sup> The addition of high-resolution mass spectrometric instrumentation can greatly enhance the ability to perform impurity profiling as it can detect trace constituents and allow retrospective analysis of collected data.<sup>33</sup>

---

<sup>28</sup> OPCW News Item, 22 October 2018, "Belgium Contributes €2M to Future OPCW Centre for Chemistry and Technology"; [www.opcw.org/media-centre/news/2018/10/belgium-contributes-eu2m-future-opcw-centre-chemistry-and-technology](http://www.opcw.org/media-centre/news/2018/10/belgium-contributes-eu2m-future-opcw-centre-chemistry-and-technology).

<sup>29</sup> OPCW News Item, 29 October 2018, "Canada Contributes CAD \$7.5M to Future OPCW Centre for Chemistry and Technology"; [www.opcw.org/media-centre/news/2018/10/canada-contributes-cad-75m-future-opcw-centre-chemistry-and-technology](http://www.opcw.org/media-centre/news/2018/10/canada-contributes-cad-75m-future-opcw-centre-chemistry-and-technology).

<sup>30</sup> OPCW News Item, 14 November 2018, "Poland to Contribute €100,000 to Future OPCW Centre for Chemistry and Technology"; [www.opcw.org/media-centre/news/2018/11/poland-contribute-eu100000-future-opcw-centre-chemistry-and-technology](http://www.opcw.org/media-centre/news/2018/11/poland-contribute-eu100000-future-opcw-centre-chemistry-and-technology).

<sup>31</sup> DSO National Laboratory, Singapore; <https://www.dso.org.sg/>.

<sup>32</sup> *Recommended operating procedures for analysis in the verification of chemical disarmament*. P. Vanninen (ed); University of Helsinki, Finland, 2017. For further information, see: <http://www.helsinki.fi/verifin/bluebook/>.

<sup>33</sup> Part 1: Tracing Russian VX to its synthetic routes by multivariate statistics of chemical attribution signatures; K.H. Holmgren, C. A. Valdez, R. Magnusson, A. K. Vu, S. Lindberg, A. M. Williams, A. Alcaraz, C. Åstot, S. Hok, R. Norlin; *Talanta*, 2018, 186, 586-596. DOI: 10.1016/j.talanta.2018.02.104.

9.5 Stable isotope ratio (IR) determination can be achieved through several techniques including GC-IRMS (Isotope Ratio Mass Spectrometry)<sup>34</sup> and IR-NMR (Isotope Ratio-Nuclear Magnetic Resonance). It has been shown that GC-IRMS can be applied to samples containing low concentrations of chemical warfare agents (CWAs) or their degradation products, down to the parts-per-million (ppm) level. IR-NMR, in contrast, requires a relatively large amount of sample (several hundred mg) and cannot be used for analysis of mixtures of organic compounds. This currently limits the application to neat CWA samples. IR-NMR, however, can potentially provide greater resolution in chemical fingerprinting through Position-Specific Isotope Analysis (PSIA).<sup>35</sup> This makes IR-NMR and GC-IRMS good complementary tools for CF. However, these techniques and the associated instrumentation are not common within the DLs and would need to be acquired.

9.6 In the subsequent discussion, the following points were raised:

- (a) IRMS is an analytical technique that provides data that is highly dependent on the measurement conditions. This means that two DLs analysing the same sample by IRMS might produce analytical information that might not necessarily agree to the level of certainty required for CA. Therefore, there is a need for more research in developing approaches to correlate databases amongst different DLs to enhance the usefulness of IRMS for CA and to realise its full potential for such applications.
- (b) How significant impurity profile data are for source attribution is unclear at present and requires further research efforts.
- (c) The establishment of databases through inter-laboratory efforts would help the development of CF for CA purposes. This would require addressing issues of data sharing and security management of databases. It was suggested that the OPCW could be the manager of such a database to encourage DLs to contribute.

---

34

(a) Stable-carbon isotope ratios for sourcing the nerve-agent precursor methylphosphonic dichloride and its products; J. J. Moran, C. G. Fraga, M. K. Nims; *Talanta*, 2018, 186, 678-683. DOI: 10.1016/j.talanta.2018.04.021 (b) The application of carbon isotope ratio mass spectrometry to doping control Adam T. Cawley, U. Flenker; *J. Mass Spectrom.*, 2008, 43, 854 – 864 DOI: 10.1002/jms.1437. (c) Forensic applications of isotope ratio mass spectrometry - a review; S. Benson, C. Lennard, P. Maynard, C. Roux; *Forensic Science International*, 2006, 157(1), 1-22. DOI: 10.1016/j.forsciint.2005.03.012.

35

(a) R. J. Robins, G. S. Remaud, S. Akoka, Serge; Isotope ratio monitoring <sup>13</sup>C nuclear magnetic resonance spectrometry for the analysis of position-specific isotope ratios; *Methods in Enzymology*, 2017, 596. DOI: 10.1016/bs.mie.2017.07.023. (b) <sup>13</sup>C nuclear magnetic resonance spectrometry <sup>13</sup>C distribution in organic molecules by isotope <sup>13</sup>C nuclear magnetic resonance spectrometry; K. Bayle, A. Gilbert, M. Julien, K. Yamada, V. Silvestre, R. J. Robins, S. Akoka, N. Yoshida, G. S. Remaud; *Anal. Chim. Acta*, 2014, 846, 1-7. (c) Isotopic <sup>13</sup>C NMR spectrometry to assess counterfeiting of active pharmaceutical ingredients: Site-specific <sup>13</sup>C content of aspirin and paracetamol; V. Silvestre, V. M. Mboula, C. Jouitteau, S. Akoka, R. J. Robins, G. S. Remaud; *J. of Pharm. Biomed. Anal.*, 2009, 50(3), 336-341. DOI: 10.1016/j.jpba.2009.04.030.

**10. AGENDA ITEM TEN – Assistance and protection: chemical forensics and evidence management**

- 10.1 Mr Guy Valente (OPCW Assistance and Protection Branch) updated the TWG on incorporation of chemical forensics and evidence management capabilities into the Article X capacity building workshops that the OPCW Assistance and Protection Branch (APB) provides.<sup>36</sup> He explained that the International Cooperation and Assistance Division (ICA), under which APB sits, is an outward looking division that seeks to provide capacity building for States Parties. Capacity building requires clarity of role, cognizance of tasks, operational competency, access to tools, and quality control. There is also a need to tailor the capacity-building programmes to the needs of individual States Parties, which are highly diverse—especially with regard to chemical evidence. Mr Valente explained how capacity-building programmes in this area are being developed, and how information and training is provided to States Parties with an emphasis on local level capacity. The information and materials that the APB collects can also be informative to OPCW operational units and provide insight into the processes through which individual States Parties respond to, and report on, incidents.
- 10.2 Mr Valente discussed the concept of external classification systems for preparedness and response, which define levels of capacity that responders can train toward. For example, the light, medium, or heavy urban search and rescue accreditation used by International Search and Rescue Advisory Group (INSARAG).<sup>37</sup> While OPCW cannot accredit the trainees with the classification, the Secretariat can use the desired capacity level of the State Party as a starting point for tailoring workshops and training to the needs (and realistic resources of) a given State Party. In this regard, insights from the TWG are valuable to the APB for identifying fieldable technologies tailored toward resource limited settings, and identifying and/or reviewing best practices for evidence management that the APB can draw upon in their training programmes. The work of the APB also has direct relevance to paragraph 20 of C-SS-4/DEC.3, where States Parties can request assistance in an investigation.
- 10.3 In the subsequent discussion, the following points were raised:
- (a) Chemical evidence will degrade, react, and undergo various environmental transport and fate processes. Training on best practices to maintain the integrity of samples is crucial.<sup>38</sup> This is of high importance for States Parties

---

<sup>36</sup> Further information on OPCW's capacity building programmes can be found at: [www.opcw.org/resources/capacity-building](http://www.opcw.org/resources/capacity-building).

<sup>37</sup> INSARAG National Accreditation Process; <https://www.insarag.org/capacity-building/national-guidelines>.

<sup>38</sup> (a) Advice on chemical weapons sample stability and storage provided by the Scientific Advisory Board of the Organisation for the Prohibition of Chemical Weapons to increase investigative capabilities worldwide; C. M. Timperley, J. E. Forman, M. Abdollahi, A. S. Al-Amri, I. P. Alonso, A. Baulig, V. Borrett, F. A. Cariño, C. Curty, D. González Berrutti, Z. Kovarik, R. Martínez-Álvarez, R. Mikulak, N. M. Fusaro Mourão, P. Ramasami, S. Neffe, S. K. Raza, V. Rubaylo, K. Takeuchi, C. Tang, F. Trifirò, F. M. van Straten, P. S. Vanninen, V. Zaitsev, F. Waqar, M. Saïd Zina, M.-M. Blum, H. Gregg, E. Fischer, S. Sun, Pei Yang; *Talanta*, 2018, 188, 808–832. DOI: 10.1016/j.talanta.2018.04.022. (b) “Response to the Director-General's Request to the Scientific Advisory Board to Provide Further Advice on Chemical Weapons Sample Stability and Storage”

with a more limited response capacity (in these situations, facilitating cooperation between States that can work together to provide a more efficient response is also important).

- (b) The importance of maintaining and defining clear roles should be emphasised and exercised—trying to define roles in real time during an incident can lead to inaction.
- (c) Interpol has a number of programmes in CBRN investigation and could potentially provide guidance. The TWG should consider inviting Interpol to a future meeting.
- (d) There are no international guidelines on chemical evidence collection, yet there are many procedures and best practices available. Collating and assessing such information could be useful for OPCW.
- (e) One open issue is the monitoring of the impact of OPCW training. This is an area that needs further attention. Tailoring training toward preparation to meet a specified external standard could help in this regard, as impact could be measured by an eventual certification of the trainees.
- (f) Another issue is how to breakdown potential silos across CBRN response. This can become an operational issue when chemical, biological, radiological and nuclear experts follow practices that are not in alignment and would complicate coordinated emergency response to a combined incident. Cooperation with other agencies on training courses could be considered.
- (g) Another area of improvement for training programmes could be to identify a specific profile for relevant participants and ensure this is the criterion used for selection. This could focus on people who will use the training and be able to train others in their State Party.

## 11. AGENDA ITEM ELEVEN – Engagement with external experts

### Subitem 11(a): International Criminal Court (ICC) Scientific Advisory Board

- 11.1 Dr Borrett, on behalf of the SAB Chair, attended the 5th Annual Meeting of the Office of the Prosecutor's (OTP's) Scientific Advisory Board of the International Criminal Court (ICC SAB) as an invited observer. The meeting was held on 21 and 22 June 2018 at the seat of the Court in The Hague.<sup>39</sup> The ICC SAB provides "...recommendations to the Prosecutor on the latest developments in new and emerging technologies, and scientific methods and procedures that can further reinforce the Office's capabilities in the collection, management and analysis of scientific evidence relating to the investigation and prosecution of crimes listed in the Rome Statute".

---

(SAB-23/WP.2, dated 25 May 2016); [www.opcw.org/sites/default/files/documents/SAB/en/sab-23-wp02\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/SAB/en/sab-23-wp02_e_.pdf).

39

ICC News Item, 8 August 2018, "The Scientific Advisory Board of the Office of the Prosecutor holds its 5th annual meeting"; <https://www.icc-cpi.int/Pages/item.aspx?name=PR1401>.

- 11.2 The ICC SAB's advice has played an important role in supporting and guiding the Forensic Science Section (comprising Forensic, Imagery, and Cyber Units) in forensic science best practices relevant to their mission. The meeting included the review of Standard Operating Procedures for forensic methods relevant to the work of the OTP and discussions on International Standardisation Organisation (ISO) accreditation.<sup>40</sup> Members of the ICC SAB are representatives of forensic associations/networks.<sup>41</sup>
- 11.3 In line with recommendations of the SAB,<sup>42</sup> TWG supports the engagement with other scientific advisory bodies to build networks and recognise experts from across a variety of fields.

**Subitem 11(b): ANZFSS 24th International Symposium on the Forensic Sciences**

- 11.4 Dr Borrett provided an overview of the Australian and New Zealand Forensic Science (ANZFSS) 24th biennial International Symposium that was held in Perth Australia from 9 to 13 September 2018.<sup>43</sup> The theme of the symposium was "Forensic Science Without Borders". There were over 700 international delegates including forensic practitioners, academics, government scientists, and representatives from industry, peak bodies, and organisations. A dedicated CBRN stream was included in the programme for the first time at ANZFSS. Plenary presentations and eight streams comprising keynotes and presentations, plus the poster sessions covered the broad spectrum of forensic disciplines. Dr Borrett was an invited plenary speaker and included the work of the OPCW SAB and the TWG on Investigative Science and Technology in her presentation.
- 11.5 The 25th ANZFSS will be held in conjunction with the International Association of Forensic Sciences Triennial Symposium IAFS 2020 from 22 to 25 September 2020 in Sydney, Australia.<sup>44</sup> The theme of IAFS 2020 will be 'Forensic Science 2020 — Where to from here?' The convenor is Professor Claude Roux, IAFS President.
- 11.6 In the subsequent discussion, it was noted that the continued engagement of the TWG and the SAB with the global forensic community would continue to benefit the investigative work of the OPCW.

**Subitem 11(c): Chemical Forensics International Technical Working Group (CFITWG)**

- 11.7 Dr Carlos Fraga, Technical Coordinator for the Chemical Forensics International Technical Working Group, provided an update on CFITWG developments since the

---

<sup>40</sup> For further information on forensics relevant ISO documents, see: Changes to Forensic Laboratory Accreditation Requirements – ISO/IEC 17025; T. Alcock, *Forensic Focus*, 2018; <https://articles.forensicro.com/2018/04/20/changes-to-forensic-laboratory-accreditation-requirements-iso-iec-17025/>.

<sup>41</sup> See paragraphs 14.1 to 14.5 of SAB-27/WP.1, dated 26 February 2018; [www.opcw.org/sites/default/files/documents/SAB/en/sab-27-wp01\\_e.pdf](http://www.opcw.org/sites/default/files/documents/SAB/en/sab-27-wp01_e.pdf).

<sup>42</sup> See paragraph 333 of Annex 1 of RC-4/DG.1 (footnote 4(a)).

<sup>43</sup> ANZFSS 24th International Symposium; <http://www.anzfss2018.com>.

<sup>44</sup> 22nd Triennial Meeting of the International Association of Forensic Science, in conjunction with the 25th Symposium of the Australian and New Zealand Forensic Science Society; <https://iafs2020.com.au/>.



previous TWG meeting, summarising the key findings and outcomes from the first CFITWG Executive Committee meeting (April 2018) and the second CFITWG meeting (August 2018). Key developments have included the expansion of participants to 14 nations and the initiation of four international collaboration projects to further develop the science and capabilities of CF. The CFITWG has also been featured in scientific news,<sup>45</sup> and its members have contributed to a virtual special issue of *Talanta* on chemical forensics.<sup>46</sup> The upcoming Third Meeting of the CFITWG will be take place during the 258th American Chemical Society National Meeting, which is to be held in San Diego from 25 to 29 August 2019.

11.8 In the subsequent discussion, the following points were raised:

- (a) The seventh JIM report presented results obtained from chemical analysis (including pre-cursor characterisation).<sup>47</sup> This information, however, was not in the form of a peer-reviewed scientific article. The report has attracted interest for the possibility of publishing scientific papers with more experimental and method details on the type of analysis that was carried out. In the absence of this, there is the chance that some of the important scientific details contained within the report are not exploited by the DL network or the CFITWG as the basis for developing new analytical options for any future chemical profiling and attribution efforts. The TWG is of the view that the details of the chemical analysis should be summarised and cross-referenced with relevant scientific literature in the form of a peer-reviewed scientific paper.
- (b) The CFITWG has brought together CF experts from relatively mature fields such as drug analysis. How these experiences and methods can help inform the work of the OPCW warrants further consideration.
- (c) The TWG encouraged the inclusion of methods that are scientifically validated for CF analysis into future editions of the Verifin Blue Book.<sup>32</sup>

## 12. AGENDA ITEM TWELVE – Forensic and investigative science

### Subitem 12(a): Digital evidence concealment and tampering

12.1 Dr Eoghan Casey (University of Lausanne, guest speaker) provided a presentation on digital evidence and its authentication. He explained that when individuals use computers and smartphones, they leave digital traces that often have associated date-time stamps. Over the past decade, there has been a steady increase in digital forensic capabilities that enable the recovery of deleted and hidden information. Such digital traces provide a detailed record of activities that can be used to address forensic questions in any type of investigation, including chronology, linkages,

---

<sup>45</sup> Attacks in UK and Syria highlight growing need for chemical-forensics expertise; D. Butler; *Nature*, 2018, 556, 285-286. DOI: 10.1038/d41586-018-04533-2.

<sup>46</sup> Virtual Special Issue: Chemical Forensics, *Talanta*, 2018; for a full list of authors and papers contained within the issue, see: <https://www.sciencedirect.com/journal/talanta/special-issue/1005VXKGRKRC>.

<sup>47</sup> See footnote 8(f).

location, activity, and identity.<sup>48</sup> As awareness of digital forensic capabilities increases, some offenders are taking actions to tamper with, conceal, or destroy evidence on the computers they use. It is even possible that an event never occurred but that a digital record was fabricated to misdirect investigators or implicate an innocent person.<sup>49</sup>

- 12.2 There are many ways that data can be destroyed, concealed, and tampered with and such actions can leave distinctive traces. However, the attempts to eliminate incriminating evidence and leave little or no remnants of tampering make forensic analysis more difficult. Even experienced forensic practitioners can overlook or misinterpret such digital traces, making it necessary to employ systematic knowledge management and forensic intelligence.<sup>50</sup>
- 12.3 Overlooking traces of concealment, destruction, and tampering can have an enormous negative impact on a forensic investigation, since the most important information is generally the target of such actions. Data that have been obliterated can give an incomplete picture of the crime.
- 12.4 Early detection of concealment, destruction, and tampering of digital traces helps avoid erroneous interpretations and enables decisions to be made to improve the overall effectiveness of the inspection. These decisions can include obtaining missing sources of information, implementing advanced recovery techniques, and involving specialists to perform more in-depth digital forensic analysis.<sup>51</sup> Conversely, promptly disproving suspicions of tampering can avoid wasted effort and potential liability that can result from a false accusation and misdirected investigation.
- 12.5 In the subsequent discussion, the following points were raised:
- (a) There are many specialised tools for analysing digital information. To take advantage of the full capabilities of any of the tools, the operator must have good familiarity with both the tool and the question being asked. It was stressed that there is a great need for a well-trained forensic case coordinator/advisor to be engaged with inspection teams that are carrying out investigative activities (whether on-site or remotely) to take advantage of the full capabilities of the tools in use.

---

<sup>48</sup> (a) *Digital Evidence & Computer Crime: Forensic Science, Computers and the Internet*; E. Casey; Academic Press; 2011. (b) *Reconstructing Digital Evidence*; E. Casey in *Crime Reconstruction*; W. J. Chisum, B. Turvey; Academic Press, 2011, Chapter 17, 531-548. DOI: 10.1016/B978-0-12-386460-4.00017-5.

<sup>49</sup> Error, Uncertainty and Loss in Digital Evidence; E. Casey; *International Journal of Digital Evidence*, 2002, 1(2).

<sup>50</sup> (a) The Kodak Syndrome: risks and opportunities created by decentralization of forensic capabilities; E. Casey, O. Ribaux, C. Roux; *Forensic Sciences*; 2018, epublication ahead of print. DOI: 10.1111/1556-4029.13849. (b) *Reinforcing the scientific method in digital investigations using a case-based reasoning (CBR) system*; E. Casey; PhD Dissertation; University College Dublin; 2013.

<sup>51</sup> The growing impact of full disk encryption on digital forensics; E. Casey, G. Fellows, M. Geiger, G. Stellatos; *Digital Investigation*; 2011, 8(2), 129-134. DOI: 10.1016/j.diin.2011.09.005.

- (b) Dr Casey indicated that it is often something unusual in the analysis that a human recognises, which initiates other avenues of inquiry and ultimately leads to the detection of concealment or tampering.
- (c) Digital forensic analysis has been challenged with respect to demonstrating that processes, activities, and techniques are sufficiently scientific, which has led to the development of recommendations for harmonising practices.<sup>52</sup>

12.6 The discussion continued with consideration of forensic intelligence and trace analysis that extended beyond digital evidence. It was noted that it is important to capture knowledge that inspectors are gaining over time in a way that would allow it to be shared across all inspections—such information could provide operational and situational awareness when linked and correlated with information from new incidents and inspections. Forensic intelligence benefits from the capturing of knowledge systematically over time. Automated information systems are essential for this capability; the Hansken software tool developed for the Netherlands Forensic Institute was highlighted as an example of such a system.<sup>53</sup>

**Subitem 12(b): Remote sampling based on unmanned ground and aerial vehicle platforms: intermediate results and way ahead of the European Defence Agency Improvised Explosive Device Detection Programme**

12.7 Mr Günter Povoden (EU CBRN Centres of Excellence Initiative, guest speaker) briefed the TWG on the Austrian Ministry of Defence-led project CONFIDENT (confirmation and identification of CBRN improvised explosive devices (IEDs)) in the European Defence Agency (EDA) IED detection programme.<sup>54</sup> The remote sampling of contaminated soil or ammunition using unmanned ground vehicle platforms (UGVs) had successfully been field tested in May 2018. Mr Povoden discussed ongoing work in the development of an air sampling system and a sampling strategy involving unmanned aerial vehicles (UAVs).

12.8 In the subsequent discussion, the following points were raised:

- (a) A variety of off-the-shelf hand-held detection devices can be integrated into UGVs. These include thermal image cameras, gamma detection systems, and handheld chemical agent detectors (including Raman and APC4 detectors),<sup>55</sup> and all can be combined with sampling systems for solids and liquids. UAVs have payload limitations as compared to a ground robot: they are more

---

<sup>52</sup> *A Framework for Harmonizing Forensic Science Practices and Digital/Multimedia Evidence*; OSAC Technical Series 0002, OSAC Task Group on Digital/Multimedia Science; 2018; [https://www.nist.gov/sites/default/files/documents/2018/01/10/osac\\_ts\\_0002.pdf](https://www.nist.gov/sites/default/files/documents/2018/01/10/osac_ts_0002.pdf).

<sup>53</sup> For further information on Hansken, see: <https://www.forensicinstitute.nl/products-and-services/forensic-products/hansken>.

<sup>54</sup> (a) EDA programme launched to improve IED detection (12 January 2017); <https://www.eda.europa.eu/info-hub/press-centre/latest-news/2017/01/12/eda-programme-launched-to-improve-ied-detection>. (b) Counter-IED (19 February 2018); <https://www.eda.europa.eu/what-we-do/activities/activities-search/counter-ied>.

<sup>55</sup> Testing of hand-held detectors for chemical warfare agents; A.-B. Gerber; *SPIEZ LABORATORY Annual Report 2015*, 38 – 39; [https://www.labor-spiez.ch/pdf/en/dok/jab/88\\_003\\_e\\_laborspiez\\_jahresbericht\\_2015\\_web.pdf](https://www.labor-spiez.ch/pdf/en/dok/jab/88_003_e_laborspiez_jahresbericht_2015_web.pdf).

commonly fitted only with imaging systems and/or 3D LIDAR (light detection and ranging of laser imaging detection and ranging).

- (b) For suitcase portable UAV systems, the range and flight time can be short for individual units (less than one hour, typically 30 minutes). UAV swarms with multiple units flying at staggered times can allow extended flight coverage and information collection (individual units can land and have batteries replaced while other units continue to generate data). The data is integrated from across the units. 3D models of an imaged area with sub-centimetre resolution are obtainable using the drone swarm approach.
- (c) The presence of a UAV allows tracking and continuous monitoring for chain of custody purposes (including monitoring individual UAVs and/or UGV activities on the ground below<sup>56</sup>).
- (d) Longer range UAV systems can be obtained using gasoline powered engines. However, the larger the range (and larger the units), the greater the logistical and operational requirements become.
- (e) The TWG raised concerns about secure data transfer and the need for encryption.
- (f) Sampling from a UAV suffers from downdraft from the rotors, which kicks up dust and liquids. A larger UAV capable of delivering and retrieving a small UGV to the sample collection site represents a possible solution.

**Subitem 12(c): Use of satellite imagery for retrospective analysis and proactive monitoring**

12.9 Mr Lars Bromley (United Nations Institute for Training and Research,<sup>57</sup> Division for Satellite Analysis and Applied Research, guest speaker) discussed the use of satellite imagery for investigations. He began with an overview of UNOSAT and the products it offers. UNOSAT provides satellite information to the coordinating agency for United Nations activities in disaster response, humanitarian response, and human rights and conflict monitoring. Support is provided on request through an official mandate of a United Nations organisation.

12.10 Mr Bromley explained that low-resolution satellite imagery is useful for large scale features and events of interest, such as large scale flooding, and that space agencies continuously collect lower resolution data. High-resolution imagery can be purchased from a number of private companies. The world is imaged on a daily basis and large volumes of data are available from open and commercial sources; however, an individual dataset only contains a subset of the available area of the Earth.

---

<sup>56</sup> Such systems have been demonstrated in environmental sampling and analysis, see for example: Sediment sampling in estuarine mudflats with an aerial-ground robotic team; P. Deusdado, M. Guedes, A. Silva, F. Marques, E. Pinto, P. Rodrigues, A. Lourenço, R. Mendonça, P. Santana, J. Corisco, S. M. Almeida, L. Portugal, R. Caldeira, J. Barata, L. Flores; *Sensors*, 2016, *16*(9), 1461-1521; DOI: 10.3390/s16091461.

<sup>57</sup> United Nations Institute for Training and Research; <http://www.unitar.org/>.

Furthermore, cloud coverage (as well as dust storms and smoke) can potentially obscure the geographical region of interest. Complete geographical locations at any desired point in time are not likely to be available, while commercial providers can focus on specific areas over a desired timeframe for monitoring purposes. The greater the area coverage requested, the greater the expense.

12.11 Mr Bromley provided examples of imagery from Iraq, the Syrian Arab Republic, and Myanmar to demonstrate capabilities in resolution and image analysis. Analysts annotate images, often by hand, requiring expertise in recognising signatures of the results of activities being monitored, e.g. disaster aftermath, conflict and war, and human mobility. Artificial intelligence methods have been reported, and there is on-going research in using these techniques for satellite image analysis. Details that can be seen in the image can be correlated with other information to identify, for example, a specific type (make and model) of vehicle, a partially burned building, or other infrastructure damage, roadblocks and checkpoints (where a building of some type exists or a line of stopped vehicles might be recognised), or even the build-up of refuse at a dumping site. Environmental signatures of disturbed earth can be indicators of mass graves. Satellite imagery has also been used to locate sites described in witness statements.

12.12 In the subsequent discussion, the following points were raised:

- (a) In regard to satellite imagery providing (bio)chemical information, Landsat satellite imagery has been used to estimate concentrations of certain chemical species in soil and water systems (which could be relevant for remote sensing of a potentially large scale chemical agent contamination),<sup>58</sup> and the SAB has previously suggested possible applications of hyperspectral and infrared satellite imagery.<sup>59</sup> Research from the use of satellite imagery applied to precision agriculture is relevant for such considerations.<sup>60</sup> Which satellite-based (bio)chemical monitoring capabilities provide reliable information vs. those that may simply be possible remains an area of interest for the SAB.

---

<sup>58</sup> See for example: (a) Mapping the total phosphorus concentration of biosolid amended surface soils using LANDSAT TM data; B. B. Sridhar, R. K. Vincent, J. D. Witter, A. L. Spongberg; *Sci. Total Environ.*, 2009, 407(8), 2894-2899. DOI: 10.1016/j.scitotenv.2009.01.021. (b) An Appraisal of the Potential of Landsat 8 in Estimating Chlorophyll-a, Ammonium Concentrations and Other Water Quality Indicators; V. Markogianni, D. Kalivas, G. P. Petropoulos, E. Dimitriou; *Remote Sens.*, 2018, 10, 1018-1039.

<sup>59</sup> (a) Innovative Technologies for Chemical Security; J. E. Forman, P. Aas, M. Abdollahi, I. P. Alonso, A. Baulig, R. Becker-Arnold, V. Borrett, F. A. Cariño, C. Curty, D. Gonzalez, Z. Kovarik, R. Martínez-Álvarez, R. Mikulak, E. de Souza Nogueira, P. Ramasami, S. K. Raza, A. E. M. Saeed, K. Takeuchi, C. Tang, F. Trifirò, F. M. van Straten, F. Waqar, V. Zaitsev, M. Saïd Zina, K. Grolmusová, G. Valente, M. Payva, S. Sun, A. Yang, D. van Eerten; *Pure Appl. Chem.*, 2018, 90(10), 1527-1557. DOI: 10.1515/pac-2018-0908. (b) "Report of the Scientific Advisory Board's Workshop on Emerging Technologies" (SAB-26/WP.1, dated 21 July 2017); [www.opcw.org/sites/default/files/documents/SAB/en/sab26wp01\\_SAB.pdf](http://www.opcw.org/sites/default/files/documents/SAB/en/sab26wp01_SAB.pdf).

<sup>60</sup> Potential of hyperspectral imaging to detect and identify the impact of chemical warfare compounds on plant tissue; M. T. Kuska, J. Behmann, A.-K. Mahlein; *Pure Appl. Chem.*, 2018, 90 (10), 1615–1624, DOI: 10.1515/pac-2018-0102.

- (b) For court cases and the use of satellite imagery in investigations, constraints in technology and capabilities of the analysts must be understood and considered when drawing conclusions.
- (c) Satellite imagery remains more commonly used for wide-scale imaging than imagery from drones. Regulatory frameworks on the use of drones are currently ad hoc across States Parties, which can restrict usage, while satellite imagery is readily available from open and commercial sources.

**Subitem 12(d): Corruption of knowledge in the authentication of reference materials: chemical weapons and art attribution**

12.13 Mr Thiago Piwowarczyk (New York Art Forensics,<sup>61</sup> guest speaker) briefed the TWG on his work in forensic attribution analysis of artwork. He noted that the history of art forensics and chemical warfare investigation is interconnected, explaining that a single family of scientific conservators have permeated both fields. He highlighted similar challenges seen in both art forensics and chemical warfare investigation, such as the possibility of corruption of knowledge, or the compromise of reference standards. For artwork, forgers have several strategies to create identities, compromise specimens, and elaborate fake narratives. He provided examples of how those techniques can be detected and fought, and explored how artwork might be used as evidence of a chemical attack and war crimes in conflict zones.

12.14 In the subsequent discussion, the following points were raised:

- (a) A key theme throughout the presentation was the use of false narratives to enhance the ability to deceive: drawing attention away from (and helping to prevent recognition of) a falsified document.
- (b) With the need to authenticate original artwork that has been damaged, a number of methods to simulate the effects of age and exposure on materials have been developed in the art forensics world to enable detection of forgeries and to identify damaged original artwork. Similarly, the research performed by DLs will help detect and identify the falsification of samples (those spiked deliberately with analytes intended to complicate analysis and confound interpretation of the results).
- (c) In the art world, dates of patents and inventions for specific materials have helped detect forgeries and fraud. Similar correlations on availability of specific materials and chemicals may be relevant to retrospective chemical warfare agent (CWA) investigations. In this regard, Mr Piwowarczyk noted that in 1916, Derix de Wild subjected dummy paintings to chlorine gas and alkali to simulate the effect of CWA exposure on the painting matrix to aid in understanding how paintings might be restored after such damage.<sup>62</sup> Archival material describing these experiments may be of interest.

---

<sup>61</sup> New York Art Forensics, Brooklyn, New York, United States of America; <https://www.nyartforensics.com/>.

<sup>62</sup> The Art of Conservation VII: Hopman and De Wild: The historical importance of two Dutch families of restorers; E. Van Duijn, M. Te Marvelde; *Burlington Magazine*; 2016, 158 (1363), 812–823.

- (d) The human factor is important in investigative work. Best practices include becoming familiar with individuals, realising that those seeking to deceive might follow similar patterns across different events (e.g. trying to deceive in a specific and consistent way), cross-referencing and rechecking standards, reviewing metadata, and looking for warning signs.
- (e) As artwork is usually maintained in a protected state, exposure to foreign substances can often be readily detected. Paintings (especially oil paintings) can absorb gases and hydrophilic materials that can be extracted from the painting; they also have large surface areas that might collect chemical signatures.

### 13. AGENDA ITEM THIRTEEN – Chemical and biomarker analysis

#### Subitem 13(a): Chlorine analysis

- 13.1 Mr Chaouki Belgacem (OPCW Inspectorate Safety and Chemistry Cell) discussed the difficulties encountered in chemical analysis to confirm exposure to chlorine gas. He began with a review of physical and chemical properties of chlorine, its wide industrial uses, and its reactivity when exposed to materials, and its environmental fate, including its impact on vegetation.<sup>63</sup> Chemicals containing the element chlorine are naturally in high abundance in the environment, and visual indicators of materials bleached and/or oxidized by chlorine might resemble those from a variety of other processes. This makes chemical analysis of chlorine exposure in environmental samples difficult. Mr Belgacem discussed components of vegetation, specifically terpenes,<sup>64</sup> which might act as markers of chlorine exposure, as well as other organic compounds that react with chlorine or hypochlorous acid (which forms when chlorine gas is exposed to water). Chemicals formed by reaction with hypochlorous acid might form also under conditions of water purification or cleaning with chlorine bleach products. Mr Belgacem also discussed possible chlorinated biomarkers, however the life time of such species appear short lived.<sup>65</sup> More research is needed to find more useful markers.

---

<sup>63</sup> (a) Environmental safety of halogenated organica by-products from use of active chlorine; J. Pickup; *Science Dossier Eurochlor*; 2010, 15; <http://www.eurochlor.org/media/14969/sd15-environmentalsafety-final.pdf>. (b) Effects of Short-term, High Exposure to Chlorine Gas on Morphology and Physiology of *Pinus ponderosa* and *Pseudotsuga menziesii*; M. D. J. Schreuderf, C. A. Brewer; *Annals of Botany*, 2001, 88(2), 187-195. DOI: 10.1006/anbo.2001.1442. (c) *Chlorine and Hydrogen Chloride*, National Academies Press, Washington D.C, 1976; <https://www.nap.edu/catalog/19934/chlorine-and-hydrogen-chloride>. (d) Damage to vegetation by chlorine gas; J. Robin, E. Harger; 1973, 4(1-4), 93-108. DOI: 10.1080/00207237308709548.

<sup>64</sup> Rearrangements induced by cationic or electron deficient sites, in *Virtual Textbook of Organic Chemistry*; W. Reusch; 2010; <https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/rearrang.htm>.

<sup>65</sup> (a) 1- $\alpha$ -Phosphatidylglycerol Chlorohydrins as Potential Biomarkers for Chlorine Gas Exposure; P. Hemström, A. Larsson, L. Elfsmark, C. Åstot; *Anal. Chem.*, 2016, 88(20), 9972–9979. DOI: 10.1021/acs.analchem.6b01896. (b) Simultaneous Measurement of 3-Chlorotyrosine and 3,5-Dichlorotyrosine in Whole Blood, Serum and Plasma by Isotope Dilution HPLC–MS–MS; B. S. Crow, J. Quiñones-González, B. G. Pantazides, J. W. Perez, W. R. Winkeljohn, J. W. Garton, J. D. Thomas, T. A. Blake, R. C. Johnson; *Journal of Analytical Toxicology*, 2016, 40(4), 264–271, DOI: 10.1093/jat/bkw011. (c) Kinetics of 3-Chlorotyrosine Formation and Loss due to Hypochlorous Acid and Chloramines; M. P. Curtis, A. J. Hicks, J. W. Neidigh; *Chemical Research in Toxicology*; 2011, 24(3), 418-42. DOI: 10.1021/tx100380d. (d) Chlorine Gas Inhalation: Human Clinical Evidence of

13.2 Describing the requirements of chemical markers, Mr Belgacem pointed to the following needs:

- (a) It is important when drawing conclusions about the presence of chlorinated organic chemicals in samples that the context in which samples were gathered be taken into account.
- (b) A short-time between exposure to chlorine and sampling is needed to maximise the chances of finding any useful signatures of exposure to chlorine gas.
- (c) The nature of the sample matrices and the degradation, hydrolysis, evaporation, and environmental fate of the marker chemicals within should be understood.
- (d) Recognising whether or not a putative “marker” chemical is present in the background matrix and is a reaction product with molecular chlorine (or other chlorine-reactive chemicals) is crucial.
- (e) The ability to quantitate and determine if the presence of chlorine containing chemicals at unusually high levels is required.
- (f) The ability to recognise chemicals formed from chlorine exposure vs. anthropogenic chlorine containing chemicals<sup>66</sup> is important.

13.3 In the subsequent discussion, the following points were raised:

- (a) Given the difficulties of discovering chlorine exposure markers, a suite of signatures, including multiple types of chemical markers (found across a range of materials) and additional types of observable signatures might need to be identified and considered.
- (b) There is limited information in the literature, as much of the chlorine chemistry studies relate to water purification<sup>67</sup> or controlled chlorination in industrial applications.<sup>68</sup>

**Subitem 13(b): Chlorine inhalation injury: targets, biomarkers, and countermeasures**

13.4 Dr Sven-Eric Jordt (Duke University School of Medicine, guest speaker) discussed the treatment of acute lung injury caused by exposure to chlorine gas, noting that

---

Toxicity and Experience in Animal Models, C. W. White, J. G. Martin; *Proc Am Thorac Soc.*; 2010, 7(4), 257-63. DOI: 10.1513/pats.201001-008SM. (e) *Toxicological Profile for Chlorine*; U.S. Department of Health and Human Services - Public Health Service - Agency for Toxic Substances and Disease Registry; 2010; <https://www.atsdr.cdc.gov/toxprofiles/tp172.pdf>.

<sup>66</sup> The Natural Production of Organohalogen Compounds; in *The Handbook of Environmental Chemistry*; G. Gribble (ed); Springer Verlag, Heidelberg; 2003, 63-84.

<sup>67</sup> Reactions of chlorine with inorganic and organic compounds during water treatment-Kinetics and mechanisms: a critical review; M. Deborde, U. von Gunten U; *Water Res.*, 2008, 42(1-2), 13-51.

<sup>68</sup> The Chlorine Industry Review, EuroChlor; <http://www.eurochlor.org/download-centre/the-chlorine-industry-review.aspx>.



effective treatment is challenging due to a lack of mechanism-based therapeutic approaches. Forensic validation of chlorine exposure and measurements of therapeutic success are compromised by the dearth of biomarkers associated with the exposure.

- 13.5 Recent studies identified Transient Receptor Potential (TRP) ion channels as targets of chemical threat agents in the respiratory chemosensory innervation and pulmonary epithelium and endothelium.<sup>69</sup> Activation of TRP ion channels causes pain, respiratory irritation, reflex dysregulation, pulmonary inflammation, and edema.<sup>70</sup>
- 13.6 Dr Jordt's research group had examined the effects of inhibitors of TRPA1 and TRPV4 ion channels in mouse and domestic pig models of chlorine exposure. Both inhibitor classes, to varying degrees, prevented pulmonary inflammation and the decline in tissue pathology, edema formation and pulmonary mechanics while improving blood oxygen saturation. Chlorinated fatty acids were identified as biomarkers of chlorine inhalation in the blood and lungs of both mice and pigs. Dr Jordt's results suggest that TRP inhibitors hold promise as possible medical countermeasures for the treatment of chlorine-induced lung injury.<sup>71</sup>
- 13.7 In the subsequent discussion, the following points were raised:
- (a) Chlorine, as well as various electrophilic irritants, that act on TRPA1 might leave unique chemical signatures. However, it is difficult to isolate enough TRPA1 from nerve endings to analyse for alterations of the protein structure.
  - (b) TRPA1 inhibitors show promise as possible medical countermeasures toward a variety of irritant chemical species (including CS).<sup>72</sup>

---

<sup>69</sup> (a) TRPs in Tox: Involvement of Transient Receptor Potential-Channels in Chemical-Induced Organ Toxicity—A Structured Review; D. Steinritz, B. Stenger, A. Dietrich, T. Gudermann, T. Popp; *Cells*, 2018, 7(8), 98-119. DOI: 10.3390/cells7080098. (b) *An official American Thoracic Society Workshop Report: chemical Inhalational Disasters. Biology of Lung Injury, Development of Novel Therapeutics, and Medical Preparedness*; E. M. Summerhill, G. W. Hoyle, S.-V. Jordt, B. J. Jugg, J. G. Martin, S. Matalon, S. E. Patterson, D. J. Prezant, A. M. Sciuto, E. R. Svendsen, C. W. White, L. A. Veress; ATS Terrorism and Inhalational Disasters Section of the Environmental, Occupational, and Population Health Assembly; *Ann. Am. Thorac. Soc.*, 2017, 14(6), 1060-1072. DOI: 10.1513/AnnalsATS.201704-297WS. (c) Tear gasses CN, CR, and CS are potent activators of the human TRPA1 receptor; B. Brône, P. J. Peeters, R. Marrannes, M. Mercken, R. Nuydens, T. Meert, H. J. Gijssen; *Toxicol Appl Pharmacol.*, 2008, 231(2), 150-156. DOI: 10.1016/j.taap.2008.04.005.

<sup>70</sup> (a) Transient receptor potential channels: targeting pain at the source; A. Patapoutian, S. Tate, C. J. Woolf; *Nature Reviews Drug Discovery*, 2009, 8, 55–68. (b) Breathtaking TRP channels: TRPA1 and TRPV1 in airway chemosensation and reflex control; B. F. Bessac, S. E. Jordt; *Physiology (Bethesda)*, 2008, 23, 360-370. DOI: 10.1152/physiol.00026.2008.

<sup>71</sup> TRPV4 inhibition counteracts edema and inflammation and improves pulmonary function and oxygen saturation in chemically induced acute lung injury; S. Balakrishna, W. Song, S. Achanta, S. F. Doran, B. Liu, M. M. Kaelberer, Z. Yu, A. Sui, M. Cheung, E. Leishman, H. S. Eidam, G. Ye, R. N. Willette, K. S. Thorneloe, H. B. Bradshaw, S. Matalon, S.-V. Jordt; *Am. J. Physiol Lung Cell Mol Physiol.*, 2014, 307(2), 158-172. DOI: 10.1152/ajplung.00065.2014.

<sup>72</sup> (a) Ankyrin-rich membrane spanning protein as a novel modulator of transient receptor potential vanilloid 1-function in nociceptive neurons; J. Peter, C. Kasper, M. Kaufholz, R. Buschow, J. Isensee, T. Hucho, F. W. Herberg, F. Schwede, C. Stein, S.-E. Jordt, M. Brackmann, V. Spahn; *Eur J Pain*, 2017, 21(6), 1072-1086. DOI: 10.1002/ejp.1008. (b) A tarantula-venom peptide antagonizes the TRPA1 nociceptor ion channel by binding to the S1-S4 gating domain; J. Gui, B. Liu, G. Cao, A. M. Lipchik, M. Perez, Z. Dekan, M. Mobli, N. L. Daly, P. F. Alewood, L. L. Parker, G. F. King, Y. Zhou,

### Subitem 13(c): Waste water epidemiology

- 13.8 Professor Kevin Thomas (Director Queensland Alliance for Environmental Health, The University of Queensland, guest speaker) briefed the TWG on the monitoring of chemical and biological markers of human activity in wastewater. He explained that concentrations of “waste” materials in wastewater effluent streams can provide information on population use, consumption, and exposure to chemicals. While many publications in the field have focused on illicit drug use,<sup>73</sup> other potential applications include exposure to industrial chemicals and pollutants,<sup>74</sup> infectious diseases and pathogens. Information related to food and beverage consumption can also be monitored.<sup>75</sup> Professor Thomas discussed established wastewater based epidemiology

---

S.-E. Jordt, M. N. Nitabach; *Curr. Biol.*, 2014, 24(5), 473-83. DOI: 10.1016/j.cub.2014.01.013. (c) Sensory detection and responses to toxic gases mechanisms, health effects, and countermeasures; B. F. Bessac, S.-E. Jordt; *Proceedings of the American Thoracic Society*, 2010, 7(4), 269-277. DOI: 10.1513/pats.201001-004SM. (d) Transient receptor potential ankyrin 1 antagonists block the noxious effects of toxic industrial isocyanates and tear gases; B. F. Bessac, M. Sivula, C. A. von Hehn, A. I. Caceres, J. Escalera, S.-E. Jordt; *FASEB J.*, 2009, 23(4), 1102-1114. DOI: 10.1096/fj.08-117812.

73

(a) Wastewater Analysis for Community-Wide Drugs Use Assessment; C. Ort, L. Bijlsma, S. Castiglioni, A. Covaci, P. de Voogt, E. Emke, F. Hernández, M. Reid, A. L. N. van Nuijs, K.V. Thomas, B. Kasprzyk-Hordern; *Handbook of Experimental Pharmacology*, 2018. DOI: 10.1007/164\_2018\_111. (b) Analysis of stimulant drugs in the wastewater of five Nordic capitals; A. S. C. Löve, J. A. Baz-Lomba, M. J. Reid, A. Kankaanpää, T. Gunnar, M. Dam, K. Ólafsdóttir, K. V. Thomas; *Science of the Total Environment*, 2018, 627, 1039-1047. DOI: 10.1016/j.scitotenv.2018.01.274. (c) Enantiomeric profiling of amphetamine and methamphetamine in wastewater: a 7-year study in regional and urban Queensland, Australia; J. Gao, Z. Xu, X. Li, J. W. O'Brien, P. N. Culshaw, K. V. Thomas, B. J. Tschärke, J. F. Mueller, P. K. Thai; *Science of the Total Environment*, 2018, 643, 827-834. DOI: 10.1016/j.scitotenv.2018.06.242. (d) Mass spectrometric strategies for the investigation of biomarkers of illicit drug use in wastewater; F. Hernández, S. Castiglioni, A. Covaci, P. de Voogt, E. Emke, B. Kasprzyk-Hordern, C. Ort, M. Reid, J. V. Sancho, K. V. Thomas, A. L.N. van Nuijs, E. Zuccato, L. Bijlsma, *Mass Spec Rev.*, 2018, 37(3), 258-280. DOI: 10.1002/mas.21525.

74

(a) European demonstration program on the effect-based and chemical identification and monitoring of organic pollutants in European surface waters; Z. Tousova, P. Oswald, J. Slobodnik, L. Blaha, M. Muz, M. Hu, W. Brack, M. Krauss, C. Di Paolo, Z. Tarcai, T. Seiler, H. Hollert, S. Koprivica, M. Ahel, J. E. Schollée, J. Hollender, M. J. F. Suter, A. O. Hidasi, K. Schirmer, M. Sonavane, S. Ait-Aissa, N. Creusot, F. Brion, J. Froment, A. C. Almeida, K. Thomas, K.E. Tollefsen, S. Tufi, X. Ouyang, P. Leonards, M. Lamoree, V. O. Torrens, A. Kolkman, M. Schriks, P. Spirhanzlova, A. Tindall, T. Schulze; *Science of the Total Environment*, 2018, 601-602, 1849-1868. DOI: 10.1016/j.scitotenv.2017.06.032. (b) Comparison of phosphodiesterase type V inhibitors use in eight European cities through analysis of urban wastewater; A. Causanilles, D. Rojas Cantillano, E. Emke, R. Bade, J. A. Baz-Lomba, S. Castiglioni, E. Castrignanò, E. Gracia-Lor, F. Hernández, B. Kasprzyk-Hordern, J. Kinyua, A. K. McCall, A. L.N. van Nuijs, B. G. Plósz, P. Ramin, N. I. Rousis, Y. Ryu, K. V. Thomas, P. de Voogt; *Environment International*, 2018, 115, 279-284. DOI: 10.1016/j.envint.2018.03.039. (c) Identification of algal growth inhibitors in treated waste water using effect-directed analysis based on non-target screening techniques; Z. Tousova, J. Froment, P. Oswald, J. Slobodník, K. Hilscherova, K. V. Thomas, K. E. Tollefsen, M. Reid, K. Langford, L. Blaha; *Journal of Hazardous Materials*, 2018, 358, 494-502. DOI: 10.1016/j.jhazmat.2018.05.031.

75

Estimation of caffeine intake from analysis of caffeine metabolites in wastewater; E. Gracia-Lor, N. I. Rousis, E. Zuccato, R. Bade, J. A. Baz-Lomba, E. Castrignanò, A. Causanilles, F. Hernández, B. Kasprzyk-Hordern, J. Kinyua, A. K. McCall, A. L.N. van Nuijs, B. G. Plósz, P. Ramin, Y. Ryu, M. M. Santos, K. Thomas, P. de Voogt, Z. Yang, S. Castiglioni; *Science of the Total Environment*, 2017, 609, 1582-1588. DOI: 10.1016/j.scitotenv.2017.07.258.

(WBE) biomarkers, current capabilities and future directions in WBE analysis, including microbiomes and exposomes.<sup>76</sup>

13.9 In the subsequent discussion, the following points were raised:

- (a) Quantitative data from wastewater epidemiology has produced more informative results than surveys for tracking drug use; the most common application for waste water monitoring project. Drug monitoring projects are often seen at national levels: Australia, for example, maintains a National Wastewater Drug Monitoring Program that makes the information collected publicly available.<sup>77</sup>
- (b) The distinguishing of drugs of consumption versus drug production is possible. An example was provided where in a drug raid, drugs were flushed down a toilet and waste water monitoring was able to determine the quantity, which was provided as evidence to the police.
- (c) For high abundance drugs of abuse, 1 ml samples can be used. For industrial chemicals larger volumes of samples are needed to concentrate enough target chemicals for detection. Large numbers of metabolites can be screened;<sup>78</sup> however, non-targeted analysis requires adequate throughput capability of samples and automated computational analysis.
- (d) Wastewater epidemiology is primarily performed by chemical laboratories. More recent work is addressing the detection and identification of faecal microbiomes,<sup>79</sup> and analysis of biological information is an area of growing interest.
- (e) WBE biomarkers can potentially be used for source attribution, especially in locating the point sources for the release of a chemical. However, legal and ethical considerations may not provide for the use of data in this way. Professor Thomas noted that in the monitoring projects he is involved, sampling that is indicative of individual buildings and homes is not permitted.

---

<sup>76</sup> Wastewater-based epidemiology biomarkers: past, present and future; P. M. Choia, B.J. Tscharka, E. Donner, J. W. O'Brien, S. C. Grant, S. L. Kaserzon R. Mackie, E. O'Malley, N. D. Crosbie, K. V. Thomas, J. F. Mueller; *Trends in Analytical Chemistry*, 2018, 105, 453-469. DOI: 10.1016/j.trac.2018.06.004.

<sup>77</sup> National Wastewater Drug Monitoring Program; <https://www.acic.gov.au/publications/intelligence-products/national-wastewater-drug-monitoring-program-report>.

<sup>78</sup> Assessing sample extraction efficiencies for the analysis of complex unresolved mixtures of organic pollutants: a comprehensive non-target approach; S. Samanipour, J. A. Baz-Lomba, M. J. Reid, E. Ciceri, S. Rowland, P. Nilsson, K. V. Thomas; *Analytica Chimica Acta.*, 2018, 1025, 92-98. DOI: 10.1016/j.aca.2018.04.020.

<sup>79</sup> (a) Sewage reflects the microbiomes of human populations; R. J. Newton, S. L. McLellan, D. K. Dila, J. H. Vineis, H. G. Morrison, A. M. Eren, M. L. Sogin; *mBio*, 2015, 6(2), e02574-14; DOI: 10.1128/mBio.02574-14. (b) Comparison of the microbial community structures of untreated wastewaters from different geographic locales; O. C. Shanks, R. J. Newton, C. A. Kelty, S. M. Huse, M. L. Sogin, S. L. McLellan; *Appl. Environ. Microbiol.*, 2013, 79(9), 2906-2913; DOI: 10.1128/AEM.03448-12.

- (f) Health surveillance data can be obtained from monitoring markers indicative of the use of medications.<sup>80</sup> Integration with orthogonal data streams provides further insight. Mobile phone data for example can be used to track movement of populations and provide correlations to the spread of a disease or pathogen.<sup>81</sup>
- (g) Quality control is extremely important in the use of waste water monitoring methodology:<sup>82</sup> data for time points taken out of context can lead to false conclusions.

#### 14. AGENDA ITEM FOURTEEN – Sub-group updates and discussion

14.1 The sub-groups established at the First Meeting of the TWG moved into breakout sessions to review the information they had compiled during the intersessional period and to identify gaps and areas needing further consideration. The sub-group leads briefed the TWG on the breakout session outcomes.

##### Sub-group A, forensic methods, and capabilities

14.2 Sub-group A discussed an inventory of capabilities related to incidents to be investigated that are listed in the sub-paragraphs below:

- (a) capabilities related to digital technologies: image analysis (e.g. authentication, meta-data, correlation of images), analysis of digital files (authentication, destruction, concealment, tampering), analysis of social media (sources, trends), document analysis, and Big Data analysis;
- (b) capabilities related to biometrics: facial recognition, fingerprint analysis, speech analysis (including voice analysis from radio communications and video clips), hand writing analysis, and DNA analysis;
- (c) capabilities related to explosions and explosives: impact analysis, and identification and profiling;

---

<sup>80</sup> Population histamine burden assessed using wastewater-based epidemiology: the association of 1,4-methylimidazole acetic acid and fexofenadine; P. M. Choi, J. W. O'Brien, J. Li, G. Jiang, K. V. Thomas, J. F. Mueller; *Environment International*, 2018, 120, 172-180. DOI: 10.1016/j.envint.2018.08.009.

<sup>81</sup> (a) Use of mobile device data to better estimate dynamic population size for wastewater-based epidemiology; K. V. Thomas, A. Amador, J. A. Baz-Lomba, M. Reid; *Environmental Science and Technology*, 2017, 51(19), 11363-11370. DOI: 10.1021/acs.est.7b02538. (b) Impact of human mobility on the emergence of dengue epidemics in Pakistan; A. Wesolowski, Taimur Qureshi, M. F. Boni, P. R. Sundsøy, M. A. Johansson, S. B. Rasheed, K. Engø-Monsen, C. O. Buckee; *Proc. Nat. Acad. Sci.*, 2015 112(38) 11887-11892. DOI: 10.1073/pnas.1504964112.

<sup>82</sup> Multi-year inter-laboratory exercises for the analysis of illicit drugs and metabolites in wastewater: development of a quality control system; A. L.N. van Nuijs, F. Y. Lai, F. Been, M. J. Andres-Costa, L. Barron, J. A. Baz-Lomba, J. D. Berset, L. Benaglia, L. Bijlsma, D. Burgard, S.Castiglioni, C. Christophoridis, A. Covaci, P.de Voogt, E. Emke, D. Fatta-Kassinos, J. Fick, F. Hernandez, C. Gerber, I. González-Mariño, R. Grabic, T.Gunnar, K. Kannan, S. Karolak, B. Kasprzyk-Hordern, Z. Kokot, I. Krizman-Matic, A. Li, X. Li, A. S.C. Löve, M. Lopez de Alda, A. K. McCall, M. R. Meyer, H. Oberacher, J. O'Brien, J. B. Quintana, M. Reid, S. Schneider, S. S. Simoes, N. S. Thomaidis, K. Thomas, V. Yargeau, C. Ort; *Trends in Analytical Chemistry*, 2018, 103, 34-43. DOI: 10.1016/j.trac.2018.03.009.

- (d) capabilities related to munitions: identification, comparison analysis, and impact analysis;
  - (e) capabilities related to chemical analysis: chemical forensics, impact of etching on materials, and production apparatus; and
  - (f) capabilities related to forensic medicine and forensic toxicology: autopsy (which requires a medical doctor, and consideration of performing on or near the location of the incident, as well as any religious constraints), analysis of human tissues and body fluids and interpretation related to cause of death or injury.
- 14.3 The sub-group identified the need for an impartial forensic advisor as a critical function for any investigation team. This advisor would act as an intermediate between the investigating team and the forensic laboratory. The advisor must have a broad background in forensic analysis and familiarity with chemical weapons issues, knowledge of applicable (inter)national laws, and knowledge of networks of forensic laboratories as well as the DLs. Operationally, the forensic advisor provides advice for the selection of exhibits to be examined in relation to the incident occurred and investigative questions, guides the phrasing of forensic questions and explains the outcome of the forensic analysis. Any individual in this role must also possess strong communication skills.
- 14.4 The sub-group also discussed the selection of laboratories for forensic analysis beyond what the DLs can provide. Considerations should include ISO 17025 accreditation, whether the labs participate in relevant proficiency testing (which should be broader than just laboratory tests, including exhibit sampling and interpretation/conclusion), capability to handle (possible) contaminated evidence, capabilities matched to investigative needs, and ensuring confidentiality requirements.
- 14.5 There is a need for identifying laboratories with geographic diversity, and establishing memorandums of understanding or other suitable relationships. The roles of government ministries, delegations and National Authorities in the working relationships with any potential partner laboratory must also be considered, as political considerations must be taken into account.
- 14.6 It was noted that some laboratories offer forensic advice as a service, allowing access to a forensic advisor; however, as OPCW has the expertise with CWA, this role cannot be entirely outsourced.

#### **Sub-group B, data collection, and management**

- 14.7 In regard to best practices and analysis tools used in the forensic sciences for effectively cross-referencing, validating, and linking together information related to investigation sites, materials collected/analysed and individuals interviewed, the sub-group reviewed literature on management of digital and physical evidence. To follow up, the sub-group intends to review OPCW procedures and identify where outside protocols can be complementary or enabling.

- 14.8 The sub-group noted that the Generic Integrated Forensic Toolbox for CBRN incidents (GIFT Forensics)<sup>83</sup> has been completed and the tools which it had developed may be of interest to evaluate. Dr van Zalen had been involved in this project and will report back to the TWG on the status if tools are available.
- 14.9 In regard to the best practices for management of data collected in investigations including compilation, curation, and analytics, the sub-group noted the work of the ICC SAB on forensic science SOPs.

#### **Sub-group C, sampling, detection, and analysis**

- 14.10 Sub-group C has compiled information on fieldable point-of-care tests for assessing exposure to classical agents (nerve agents and sulfur mustard), point-of-care devices and technologies for detection of ricin, commercially available technologies for on-site chemical detection/identification in the environment, and point-of-care devices and technologies detecting toxic industrial chemicals (TICs). While these are interim lists for the final report of the TWG, the content is available for review by the Secretariat through the Science Policy Advisor. It was suggested that the sub-group cross reference their lists with the lists of approved equipment from the Secretariat.
- 14.11 In regard to TICs, consideration of techniques and methods used in industry would provide further information on detection, early warning monitoring, bio-monitoring and personal protective equipment (PPE).
- 14.12 The sub-group intends to interview available operational staff to identify needs for point-of-care capabilities. Matching of technologies to specific chemicals of concern (including available UGV and UAV mounted systems for sampling and analysis) was also discussed. In this regard, attending equipment evaluation workshops and/or organising a workshop to evaluate specific technologies may be of value.

#### **Sub-group D data collection and integrity of scene, evidence and evidence collection**

- 14.13 In regard to best practices for the collection, handling, curation and storage and annotation of evidence, the sub-group has been reviewing operating protocols and procedures to identify areas that might benefit from the exploration of new tools and methods. Comparison of these protocols and procedures with those used by others for forensic fieldwork (such as those from the Netherlands Forensic Institute (NFI)<sup>84</sup>) is a next step; suitable guest speakers will be invited to future meetings of the TWG.
- 14.14 In regard to exploring how others approach the reconstruction of past events and physical locations, the sub-group identified the following areas for further review: reviewing of operating procedures used by others for the evaluation of inspected areas, the application of integrated approaches to forensic investigations of threat agents, and the use of environmental features (for example, endogenous plants) to provide information (e.g. “if plants could talk”<sup>85</sup>).

---

<sup>83</sup> GIFT Forensics; <https://giftforensics.eu/>.

<sup>84</sup> Netherlands Forensic Institute (NFI); <https://www.forensicinstitute.nl/>.

<sup>85</sup> See references provided in footnotes 59 and 60.

- 14.15 A workshop on site mapping and documentation, which could review UAVs, imaging analysis, 3D and 2D scanning, new sensors, and RFID tagging was suggested.
- 14.16 Additionally, it was suggested to review the procedures and equipment for sample packaging and transport.

#### **Sub-group E, provenance**

- 14.17 In regard to coordination with, and encouragement of laboratories to be more actively engaged with, the CFITWG, the TWG, and OPCW Secretariat have provided contacts and support to the CFITWG leadership for the recruitment of experts from DLs and other international organisations between the First and Second CFITWG meetings. Countries represented now include: Australia, Canada, Finland, France, Germany, the Netherlands, Norway, Serbia, Singapore, Spain, Sweden, Switzerland, the United States of America, and the United Kingdom of Great Britain and Northern Ireland. Participating international organisations include defence laboratories, national laboratories, law enforcement laboratories, forensic laboratories (and organisations), and academic institutions. The majority of the CFITWG laboratories are or will be participating in at least four collaborative CFITWG projects.
- 14.18 In regard to identifying others whose work relies heavily on provenancing (for example, food authentication and oil spill forensics), the sub-group recommended requesting presentations from experts from areas that rely heavily on provenancing (e.g. food forensics, environmental forensics, illicit drug forensics and bio-toxin sourcing). There is a need to learn best practices on the standardisation, storage, and maintenance of instrumental data (raw and/or process) for chemical forensics application.
- 14.19 In regard to reviewing protocols of others, including the tools and methods used (IRMS, SNIF-NMR and inorganic analysis for example), the 5<sup>th</sup> ACS Chemical Forensics Symposium (held in Boston in August 2018) included several speakers that presented on methods for stable isotope analysis for chemical forensics and related applications (specifically, IRMS and NMR). The CFITWG has also proposed to write a critical review paper that will include a summary and assessment of tools and methods relevant to chemical forensics (i.e. chemical provenancing).
- 14.20 In regard to considering chemical forensic analysis in biological samples (including human, animal, and plants), CFITWG member and SAB/TWG member Dr Daan Noort is championing this effort for the CFITWG. It is worth examining the possibility of using stable Isotope ratios as possible chemical attribution signatures.
- 14.21 Exploring the feasibility of access to data from past chemical weapon investigations for the review of the scientific approaches and results has not yet started. One approach may involve a coalition of the willing (e.g., former CWA production countries) to ascertain old data and information that might be mined. Another possible approach is to compile and process open publications (for example, those on chemical profiling of CWA in old munitions or storage containers<sup>86</sup>) on possible CA signatures

---

86

See for example: Determination of mustard and lewisite related compounds in abandoned chemical weapons (Yellow shells) from sources in China and Japan; S. Hanaoka, K. Nomura, T. Wada; *J. Chromat. A*, 2006, 1101(1–2), 268-277. DOI: 10.1016/j.chroma.2005.10.028.

and compare the collected data with signatures discovered in recent publications, for example, those on sulfur mustard.<sup>87</sup> The likelihood of getting beneficial information is potentially low given that the chemical analysis performed in the past asked different questions and is therefore potentially irrelevant; also raw data might not be available.

- 14.22 The sub-group was of the view that the OPCW should keep samples and raw data in a format that can be used in the future for chemical forensics applications. A CFITWG collaboration project is currently analysing current lab stocks of Schedule 1 chemicals (for which there is detailed metadata): this should provide a good test case.
- 14.23 In regard to stakeholders that the Secretariat could usefully engage with to leverage their capabilities on investigative matters, the following were suggested: NFI, ITWG,<sup>88</sup> Interpol, and CFITWG.
- 14.24 For best practice of storing samples for forensic analysis for CWAs and their degradation products, advice from the SAB should be considered.<sup>38</sup>

#### **Sub-group F, additional considerations**

- 14.25 In the effort to identify how modern investigative techniques can strengthen the OPCW's ability to investigate the use of chemical weapons or other activities prohibited by the Convention, the experiences of OPCW inspectors are essential input.
- 14.26 Traditional approaches are not suitable for situations in which inspectors are not able to travel to sites to be inspected or in which witnesses are unable to meet with inspectors because of travel difficulties.
- 14.27 Inspector time on-site may be very limited and return visits not possible. Thus, there is a need to identify and discuss possible ways to enable inspectors to document a site rapidly and to collect as much relevant information on-site as possible.
- 14.28 A number of non-traditional means for collecting relevant information have been identified and should be further assessed by the group. Possibilities include: use of unmanned aerial vehicles to conduct tasks at the site of interest, perhaps in combination with actions by local personnel; smartphone apps to assist in collection and authentication of information; and use of open-source imagery or other information, including means to confirm its authenticity.
- 14.29 Technical investigative assistance to States Parties may involve OPCW personnel in a process leading to domestic criminal prosecution. This could raise a number of potential complex legal issues that may require need consideration.
- 14.30 One priority area for sub-group F identified at the First Meeting of the TWG, "consider how to increase and improve sustainability of field missions" should be

---

<sup>87</sup> Synthesis route attribution of sulfur mustard by multivariate data analysis of chemical signatures; K. H. Holmgren, S. Hok, R. Magnusson, A. Larsson, C. Åstot, C. Koester, D. Mew, A. K. Vu, A. Alcaraz, A. M. Williams, R. Norlin, D. Wiktelius; *Talanta*, 2018, 186, 615-621. DOI: 10.1016/j.talanta.2018.02.100.

<sup>88</sup> Nuclear Forensics International Technical Working Group (ITWG); <http://www.nf-itwg.org/>.



reconsidered. Considering way in which inspectors can collect the greatest amount of information under the time constraints and limited access they may face would be more useful.

## 15. AGENDA ITEM FIFTEEN – Recent incidents

### Subitem 15(a): A thwarted bioterrorism event in Cologne, Germany

- 15.1 Dr Brigitte Dorner reported on a thwarted bioterrorism incident in Cologne, Germany.<sup>89</sup> On June 12, 2018 Sief Allah H., a Daesh (ISIS) sympathiser, was taken into custody in his flat in a police raid by special police forces: the suspect is accused of having planned the construction of an improvised explosive device containing ricin. He had procured more than 3000 *Ricinus communis* seeds and started producing the toxin based on a terrorist manual. Later evidence indicated that his wife Yasmin H. supported him in this endeavour; she was taken into custody in July.
- 15.2 Dr Dorner described the methodology that was successfully applied to the analysis of evidence in the case: a combination of a highly specific ricin-ELISA, followed by LC-MS/MS identification and an activity measurement based on a real-time cytotoxicity assay provided a reliable toolbox for the characterisation of evidence. Lateral Flow Assays (LFAs) had been used on-site in the context of hazard prevention by specialised personnel from fire departments. While LFAs provide a first indication on the agent, they have clear technical limitations—any results obtained with LFAs must be corroborated in a specialised laboratory. Dr Dorner presented and discussed lessons learned from the ongoing investigation.
- 15.3 Additionally, Dr Dorner updated the TWG on the outcomes of the EQuATox project that had concluded in 2014.<sup>90</sup> A new project, EuroBioTox, began in June 2017.<sup>91</sup> Recent developments include the preparation of Staphylococcal enterotoxin B (SEB) reference material. EuroBioTox will hold a workshop in 2020 looking at on-site detection of toxins.
- 15.4 In the subsequent discussion, the following points were raised:
- (a) Lessons learned, when available, from this incident will be valuable to review for understanding efficient sampling strategies. Mechanisms available to share experiences and lessons learned on this incident with the Secretariat should be explored.
  - (b) There are currently no forensic laboratories in the EuroBioTox project. The TWG sees value in engaging forensic science laboratories and experts in the initiative.

---

<sup>89</sup> Der Generalbundesanwalt beim Bundesgerichtshof: Erklärung zum gegenwärtigen Stand der Ermittlungen gegen Sief Allah und Yasmin H.; 03.08.2018 - 43/2018; <https://www.generalbundesanwalt.de/de/showpress.php?themenid=20&newsid=788> (in German).

<sup>90</sup> Establishment of Quality Assurance for the Detection of Biological Toxins of Potential Bioterrorism Risk (EQuATox); <http://www.equatox.org/>.

<sup>91</sup> European programme for the establishment of validated procedures for the detection and identification of biological toxins (EuroBioTox); <https://eurobiotox.eu/>.

- (c) The incident described by Dr Dorner required a great deal of interagency coordination. Training and planning for these operations is important to establish before an incident occurs to allow an efficient and coordinated response. This would be especially important for the OPCW if it were asked to assist a State Party.
- (d) Decontamination of ricin at the incident site was briefly discussed. The recommended procedures used by emergency responders are available.<sup>92</sup>
- (e) The OPCW Lab will hold a third biotoxin exercise to continue developing toxin identification methods within the DLs.<sup>93</sup>

#### **Subitem 15(b): OPCW Technical Assistance Visits (TAVs)**

- 15.5 Dr Blum briefed the TWG on the TAVs to the United Kingdom of Great Britain and Northern Ireland in response to the incidents in Salisbury and Amesbury in 2018.<sup>16,94</sup> In both of the missions, environmental and biomedical samples were obtained and analysed by DLs. An unscheduled chemical, which was identified as a type of nerve agent, was found in both TAVs. Dr Blum described the deployment and modalities of the two TAVs.

#### **Subitem 15(c): Related work of the Scientific Advisory Board**

- 15.6 In May 2018, following a review of the findings of the March 2018 TAV in response to the Salisbury incident, the Director-General requested the SAB to provide advice on toxic chemicals that have been identified as, or are suspected of belonging to, a new generation of nerve agents.<sup>95</sup> Mr Cheng Tang and Dr Jonathan Forman (Science Policy Adviser and Secretary to the SAB) briefed the TWG on the SAB's findings and recommendations.<sup>96</sup>
- 15.7 The Director-General's request asked the SAB to take guidance from the chemicals reviewed by the Board in 2011<sup>97</sup> and any close analogues. As these chemicals had been associated in open literature with the "Novichok" terminology used to describe the chemical identified in the Salisbury Incident, this provided a starting point for the SAB's considerations. The SAB reviewed public information with chemical structures

---

<sup>92</sup> (a) *National Response Team (NRT) Quick Reference Guide (QRG) for Ricin* (2013); [https://www.nrt.org/sites/2/files/1304\\_Ricin\\_QRG\\_FINAL.pdf](https://www.nrt.org/sites/2/files/1304_Ricin_QRG_FINAL.pdf). (b) Response to a Ricin Incident: Guidelines for Federal, State, and Local Public Health and Medical Officials (CAN Corporation, IPR 11740, June 2006); [https://emergency.cdc.gov/agent/ricin/pdf/ricin\\_protocol.pdf](https://emergency.cdc.gov/agent/ricin/pdf/ricin_protocol.pdf).

<sup>93</sup> "Call for Nominations for the Third Exercise on the Analysis of Biotoxins" (S/1674/2018, dated 24 September 2018); [www.opcw.org/sites/default/files/documents/2018/09/s-1674-2018%28e%29.pdf](http://www.opcw.org/sites/default/files/documents/2018/09/s-1674-2018%28e%29.pdf).

<sup>94</sup> For further information, see the Incident in Salisbury section of the OPCW public website; [www.opcw.org/media-centre/featured-\(a\)opics/incident-salisbury](http://www.opcw.org/media-centre/featured-(a)opics/incident-salisbury).

<sup>95</sup> "Request for Information from States Parties on New Types of Nerve Agents" (S/1621/2018, dated 2 May 2018); [www.opcw.org/sites/default/files/documents/S\\_series/2018/en/s-1621-2018\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/S_series/2018/en/s-1621-2018_e_.pdf).

<sup>96</sup> "Response to the Director-General's Request to the Scientific Advisory Board to Provide Advice on New Types of Nerve Agents" (SAB-28/WP.1, dated 3 July 2018). Mr Tang and Dr Forman repeated to the TWG a briefing they had provided for States Parties on 9 July 2018.

<sup>97</sup> See paragraphs 11.1 to 11.3 of the "Report of the Scientific Advisory Board at its Sixteenth Session" (SAB-16/1, dated 6 April 2011); [www.opcw.org/sites/default/files/documents/SAB/en/sab-16-01\\_e\\_.pdf](http://www.opcw.org/sites/default/files/documents/SAB/en/sab-16-01_e_.pdf).

associated with Novichok terminology, peer-reviewed scientific publications, and patent literature. The Board identified a set of chemical families that may have relevance to the chemical confirmed in the Salisbury Incident—however, for some of the chemical structures that would fall under these families, no experimental methods or data have been reported in peer-reviewed scientific or open literature; and almost no technical information (in particular, toxicological information) was available in the open and scientific literature. The SAB also could not identify any currently established uses of the chemical families it identified for purposes not prohibited by the Convention.

15.8 The SAB recommended that the Secretariat consider the chemical families in the report and increase its knowledge to:

- (a) detect such chemicals in the field, both to protect inspectors, and to allow them to carry out verification or assistance activities;
- (b) provide inspectors with training and equipment that will afford a high level of protection;
- (c) provide inspectors and any other Secretariat staff responsible for assistance missions with appropriate training and medical countermeasures to respond to, and/or advise on, any potential exposure;
- (d) ensure safe handling of samples at all times from sampling and transport through to analysis, and storage or destruction;
- (e) have reference standards and data for these chemicals, and their precursors and degradation products, in order to establish recommended analytical methods and to enable direct comparison of measurements and spectra; and
- (f) assist States Parties to strengthen their protection capabilities.

15.9 The SAB noted that none of the information required to develop the capabilities called for in these recommendations currently exists in open or scientific literature and urged States Parties to share such information with the Secretariat in a manner that minimises the risk of contributing to proliferation of new types of nerve agents. When such information is available to the Secretariat, the SAB may be in a position to provide additional scientific advice.

15.10 With respect to sampling and analysis, the SAB recommended the OPCW Laboratory and the DLs be prepared to analyse future samples for the possible presence of the new types of nerve agents (and their analogues). DLs and States Parties were encouraged by the SAB to contribute relevant spectra for new types of nerve agents, along with their precursors and degradation products, for inclusion in the OPCW Central Analytical Database (OCAD).

15.11 In line with the SAB's recommendations to the Fourth Review Conference on chemicals,<sup>98</sup> the Board also recommended to consider whether any changes to the

---

<sup>98</sup> See paragraph 24 of RC-4/DG.1 (footnote 4(a)).

Schedules, involving new nerve agents and their precursors, would be warranted to ensure appropriate restrictions on, and monitoring of, such chemicals.

15.12 In October 2018, a proposed change to Schedule 1 of the Annex on Chemicals was jointly submitted by Canada, the Netherlands, and the United States of America, following the procedure of Article XV, paragraph 5.<sup>99</sup> The proposed change would add two new chemical families to Schedule 1. This proposal is under evaluation as required by Article XV, and will be discussed by the Executive Council in 2019.<sup>100</sup>

## **16. AGENDA ITEM SIXTEEN – Next steps, agendas and dates for meetings in 2019**

16.1 Dr Borrett facilitated a discussion amongst the TWG on priority areas for its future work. As part of the planning, Dr Forman discussed timelines and milestones for the work of the TWG and the SAB. The TWG's term of reference will reach its end in February of 2020 and a substantive report of its findings alongside recommendations is expected.

(a) The TWG intends to hold three additional meetings. The Third and Fourth Meetings will tentatively be held in April and September 2019. These meetings should include briefings on open source intelligence analysis and other non-traditional methods of obtaining information from difficult to access environments, and the possibility of equipment evaluation.

(b) The Fifth Meeting is anticipated to be dedicated to report writing and will tentatively be held in November 2019.

## **17. AGENDA ITEM SEVENTEEN – Adoption of the report**

The TWG considered and adopted the report of its Second Meeting.

## **18. AGENDA ITEM EIGHTEEN – Closure of meeting**

The Chairperson closed the meeting at 17:47 on 16 November 2018.

## **ACKNOWLEDGEMENTS**

The TWG members thank all the guest speakers and staff of the Secretariat who gave presentations at their Second Meeting: Mr Nihad Alihodzic, Mr Chaouki Belgacem, Dr Marc-Michael Blum, Mr Lars Bromley, Mr Leo Buzzerio, Dr Eoghan Casey, Ms Hoe-Chee Chua, Mr Shawn DeCaluwe, Dr Luis Gaya, Dr Michael Hoefler, Dr Sven-Eric Jordt, Mr

---

<sup>99</sup> “Joint Proposal by Canada, the Netherlands, and the United States Of America for a Technical Change to Schedule 1 of the Annex on Chemicals to the Chemical Weapons Convention” (S/1682/2018, dated 25 October 2018).

<sup>100</sup> A second proposal for a technical change to the Annex on Chemicals was also submitted on 30 November 2018 (two weeks after the conclusion of the TWG meeting) by the Russian Federation. This proposal, intending to add five families of chemicals to the Annex on Chemicals, will also be considered in 2019 following the required timelines of Article XV. See, “Proposals to Introduce Additions to the Schedules of Chemicals of the Annex on Chemicals to the Convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on Their Destruction” (S/1697/2018, dated 7 December 2018).

Thiago Piwowarczyk, Mr Günter Povoden, Ms Veronika Stromsikova, Professor Kevin Thomas, Mr Guy Valente and Dr Gareth Williams. The TWG also thanks Ms Nadine Gürer, Ms Maria Hemme, Ms Nadezda Malyutina, Ms Marlene Payva and Ms Sofia Sola of the OPCW Office of Strategy and Policy, for their support and contributions to the meeting and its preparations. The members of the TWG and the SAB also express appreciation to the Director-General for his interest in, and support to, the work programme described herein.

Annex: List of Participants at the Second Meeting of the Scientific Advisory Board's Temporary Working Group on Investigative Science and Technology

**Annex****LIST OF PARTICIPANTS AT THE SECOND MEETING OF THE SCIENTIFIC ADVISORY BOARD'S TEMPORARY WORKING GROUP ON INVESTIGATIVE SCIENCE AND TECHNOLOGY<sup>101</sup>**

|     | <b>Participant</b>                       | <b>Institution</b>   |
|-----|--|--|
| 1.  | Dr Crister Åstot                         | Swedish Defence Research Agency (FOI), Umeå, Sweden  |
| 2.  | Dr Augustin Baulig                       | Secrétariat général de la défense et de la sécurité nationale, Paris, France   |
| 3.  | Dr Veronica Borrett* <sup>102</sup>      | BAI Scientific and Honorary Fellow, University of Melbourne, Australia   |
| 4.  | Dr Christophe Curty* <sup>103</sup>      | Spiez Laboratory, Switzerland  |
| 5.  | Dr Brigitte Dorner                       | Robert Koch Institute, Berlin, Germany   |
| 6.  | Dr Carlos Fraga                          | Pacific Northwest National Laboratory, Richland, Washington, United States of America  |
| 7.  | Dr Robert Mikulak*                       | Department of State, Washington, DC, United States of America  |
| 8.  | Dr Daan Noort*                           | TNO, Rijswijk, the Netherlands   |
| 9.  | Dr Syed K. Raza*                         | Chairperson Accreditation Committee, National Accreditation Board for Testing and Calibration Laboratories (NABL), India                     |
| 10. | Mr Valentin Rubaylo*                     | State Scientific Research Institute of Organic Chemistry and Technology, Moscow, Russian Federation  |
| 11. | Mr Cheng Tang* <sup>104</sup>            | Office for the Disposal of Japanese Abandoned Chemical Weapons, Ministry of National Defence, China  |
| 12. | Dr Christopher Timperley* <sup>105</sup> | Defence Science and Technology Laboratory (Dstl), Porton Down, United Kingdom of Great Britain and Northern Ireland                          |
| 13. | Mr Francois Mauritz van Straten*         | Chemical Weapons Working Committee, South Africa   |
| 14. | Dr Ed van Zalen <sup>106</sup>           | Netherlands Forensic Institute (NFI), the Netherlands  |
| 15. | Professor Paula Vanninen                 | University of Helsinki and VERIFIN, Helsinki, Finland  |
| 16. | Ms Farhat Waqar*                         | Pakistan Atomic Energy Commission  |
| 17. | Mr Lars Bromley (guest speaker)          | United Nations Institute for Training and Research, Division for Satellite Analysis and Applied Research, New York, United States of America |
| 18. | Dr Eoghan Casey (guest speaker)          | University of Lausanne, Switzerland  |

<sup>101</sup> Professor David Gonzalez sent his apologies and was unable to this meeting of the TWG.

<sup>102</sup> Chairperson of the TWG.

<sup>103</sup> 2019 Vice-Chairperson of the SAB.

<sup>104</sup> 2018 Vice-Chairperson/2019 Chairperson of the SAB.

<sup>105</sup> 2018 Chairperson of the SAB.

<sup>106</sup> Vice-Chairperson of the TWG.

|     | <b>Participant</b>   | <b>Institution</b>   |
|-----|--|--|
| 19. | Ms Hoe-Chee Chua* (guest speaker)                                | DSO National Laboratories, Singapore   |
| 20. | Dr Sven-Eric Jordt (guest speaker)                               | Duke University School of Medicine, Durham, North Carolina, United States of America |
| 21. | Mr Thiago Piwowarczyk (guest speaker)                            | New York Art Forensics, Brooklyn, United States of America                           |
| 22. | Mr Günter Povoden* <sup>107</sup> (guest speaker)                | EU CBRN Centres of Excellence Initiative, Austria                                    |
| 23. | Professor Kevin Thomas (guest speaker)                           | The University of Queensland, Brisbane, Australia                                    |
| 24. | Dr Jonathan Forman (Secretary to the SAB, Technical Secretariat) | Organisation for the Prohibition of Chemical Weapons, The Hague, the Netherlands     |

\*Member of the Scientific Advisory Board.

--- 0 ---

---

<sup>107</sup>

Appointed to the SAB from 1 January 2019.