



Thirty-Sixth Session
26 - 29 September 2022

SAB-36/WP.1
29 July 2022
ENGLISH only

SUMMARY OF THE FOURTH MEETING OF THE SCIENTIFIC ADVISORY BOARD'S TEMPORARY WORKING GROUP ON ANALYSIS OF BIOTOXINS

1. AGENDA ITEM ONE – Opening of the meeting

- 1.1 The Temporary Working Group (TWG) on the Analysis of Biotoxins of the Scientific Advisory Board (SAB) held its fourth meeting on 29 and 31 March 2022 in a virtual format. The meeting was chaired by Dr Daan Noort on behalf of the SAB, with Dr Suzy Kalb designated as Vice-Chairperson.
- 1.2 The TWG Chairperson opened the session welcoming TWG members, external speakers and observers to the fourth official meeting of the TWG. He noted that the focus of this meeting was to receive detailed updates and next steps from the five subgroups.

2. AGENDA ITEM TWO – Adoption of the agenda

- 2.1 The TWG adopted the following agenda for its fourth meeting:
 1. Opening of the meeting (TWG Chairperson)
 2. Adoption of the agenda (All)
 3. Update on TWG progress (TWG Chairperson and Vice-Chairperson)
 4. Subgroup Readouts/Updates (All)
 5. The role of forensics in the support of the attribution process (Dr Robert Bull)
 6. Next Steps (All)
 7. Any other business (All)
 8. Closure of the meeting (TWG Chairperson)

3. AGENDA ITEM THREE – Update on TWG progress

- 3.1 The TWG Chairperson provided an update on the progress of the TWG, and noted the three very productive virtual sessions and numerous subgroup meetings held to date. He indicated that the current meeting would be focused more on subgroup readouts and discussions related to how the group can finalise its answers to the overarching questions listed in the group's mandate.



3.2 The Chairperson further provided an overview of some of the key points and questions raised during the previous TWG meetings, including:

- (a) The need for mass spectrometry databases for both proteins and small molecular weight toxins;
- (b) The availability of reference standards is crucial;
- (c) An additional problem, especially important in the case of food toxins, is how to prove alleged use in view of occurrence of natural background levels (in this respect, quantification is important);
- (d) Linking international projects on the topic of quality assurance is important;
- (e) Complementary methods for analysis are needed – not just mass spectrometry-based approaches; and
- (f) How best to extrapolate the knowledge built up during the various exercises towards new security relevant toxins?
- (g) Should the approach to considering the risk of new toxins be formalised?
- (h) Should the approach to detection and identification of new toxins be standardised?
- (i) Do reporting requirements among the various mechanisms/organisations need to line up?

3.3 Turning to the format of the final report, the Chairperson provided an example of the final report of the previous TWG on Investigative Science and Technology. He suggested utilising a similar layout with similar sections for readability. Visualisations/graphics for key concepts can be included to improve the report. It was suggested that subgroups think about which parts of the report (what particular information) should be supported by visuals. As for recommendations, the objective will be to prioritise/extract a smaller subset to highlight to the Director-General while also providing the full list for consideration.

4. AGENDA ITEM FOUR – Subgroup readouts

4.1 Each of the subgroups were invited to provide a progress report on their work, highlighting what work was left to do and how they would ensure on-time completion. The overarching questions being considered by each subgroup are:

- (a) What are the underlying requirements for the analysis of biological toxins in order to investigate alleged use of toxic chemicals as weapons? (subgroup 1)
- (b) What classes of biological toxins are most likely to be relevant in investigations of alleged use? (subgroup 2)
- (c) Are there other relevant compounds of biological origin that should also be considered based on their potential for misuse or technological change associated with them? (subgroup 2)

- (d) What are the technical requirements for analysis of the most relevant types of biological toxins? (subgroup 3)
- (e) What are the analytical standards and requirements of other international and national investigative authorities and how do these compare and/or factor into OPCW considerations and operations? (subgroup 4)
- (f) How can programmes of analytical exercises conducted by different networks of laboratories be coordinated or harmonised to minimise duplication, promote consistent practices, and develop a comprehensive picture of laboratory capabilities? (subgroup 4)
- (g) What institutional or legal measures need to be established to facilitate cooperation between the OPCW and other organisations working on the development of capabilities for the analysis of biological toxins? (subgroup 5)

Subgroup 1

- 4.2 Dr Clark (subgroup leader) provided an overview of the main points outlined in the subgroup's draft report, focusing on aspects unique to the investigation of biotoxins (as opposed to those common/consistent with the analysis for traditional chemical weapon agents). The subgroup identified five stages to the process of investigation of the alleged use of a biotoxin, including:
- (a) Sample collection (i.e., may include in-field detection and analysis, to collect relevant samples/evidence);
 - (b) initial screening of samples within an appropriate facility (i.e., safety triage and corroborating any in-field identification);
 - (c) unequivocal analysis and identification of the presence of biotoxin;
 - (d) forensic sample and analysis (i.e., to potentially identify provenance or source for attribution purposes, including analysis of potential markers of how the toxin was purified or characteristics of geographical origin); and
 - (e) reporting to the OPCW.
- 4.3 Speaking of sample collection and in-field detection and analysis, Dr Clark noted that one of the principal differences between biotoxins and classical chemical warfare agents is the challenge associated with detecting and identifying their presence in the field, as there is no universal technique for their detection. The principal mode of in-field detection would be either a suite of lateral flow assays (handheld assays) or the use of emerging automated platform technologies. Other direct methods for detection of biotoxins include identifying the presence of DNA from the original source organism (bacteria, plant-based) being carried through to identification within a fieldable polymerase chain reaction (PCR) platform technology. One of the challenges is the diversity of the matrix that could be present (solid, liquid, food, clinical samples, etc.) as well as the potential for natural incidence (e.g., botulinum outbreaks, exposure to ricin/abrin). One of the biggest differentiators from traditional chemical warfare agent analysis is the delayed identification of a biotoxin incident, where it can sometimes take

days for symptoms of exposure to appear/be diagnosed. One of the first indications could be clinical diagnosis (increased incidents of symptoms) or even post-humous pathological identification.

- 4.4 Initial screening of samples would not differ significantly from what is done for chemical weapons. Regarding unequivocal analysis, in addition to the minimum of two independent laboratories to analyse the samples generated following an investigation, it would be preferable that labs have a history of relevant expertise and research in the field of biotoxins and/or participation in relevant external quality assessment. It is also suggested a minimum of two orthogonal techniques be used to unequivocally characterise the presence of a biotoxin in a sample.
- 4.5 Dr Clark then moved on to forensic sample analysis, noting that chain of custody underpins provenance. It is important to understand how familiar analytical labs are with chain of custody procedures. The extensive amount of laboratory paperwork involved in a forensic investigation should also be considered. This is especially important in relation to chain of custody.
- 4.6 He further noted the importance of differentiating natural incidence from nefarious use, including markers of source, route of production, and the presence of purified or crude material, which may indicate intent. The importance of availability of certified reference materials for biotoxins was also emphasised.
- 4.7 As for the final stage of the process, reporting to the OPCW, Dr Clark noted that results should be reported with appropriate caveats or limitations outlined, such as limits of detection or the presence of matrix effects. Ideally, techniques should be accredited or validated to a standard.
- 4.8 It was pointed out that source attribution from sample analysis alone may not be possible, although it may be possible to determine whether two samples are closely related. For example, it would require having a comprehensive data on ricin plants, ricin isoforms, growth phases from different locations in the world, etc. However, there are many parameters that are ill-described or not described at all. The potential for synthetic biology to be used to synthesise a toxin is notable. There was a rich discussion on whether a lab-created toxin or bioregulator could be differentiated from one sourced from a natural origin.
- 4.9 The group discussed the importance of using scientifically recognised tools in different labs that could lead to the same results if there are different samples to be compared. For example, if comparison could be done by three different labs with the same pre-approved methodology - a recommendation could be to encourage sharing of methodologies and trying and testing of different tools to see if those could be reliable methods for forensic analysis of biotoxins. It is important that the OPCW know which laboratories possess the appropriate analytical tools and methodologies such that they can be called upon to support in any investigation.
- 4.10 Lastly, there was a discussion on the utility of the OPCW and United Nations Secretary-General's Mechanism for Investigation of Alleged Use of Chemical and Biological

Weapons (UNSGM¹) purposely focusing on different types of security relevant toxins in order to avoid redundancy. The two organisations could consider harmonising their exercises, testing and reporting requirements to enable seamless cooperation in the future. Their respective efforts to prepare to respond to biotoxin incidents should benefit each other so as to not be duplicative but instead cooperative in this area. It was pointed out that there may also be political elements involved and this would need to be navigated.

Subgroup 2

- 4.11 Dr Bossée (subgroup leader) provided an overview of the subgroup's work on developing a list of toxins that are most relevant for consideration by the TWG in relation to the overarching questions being considered by the group. She noted the different criteria they considered, such as previous weaponisation, and ultimately used to develop a list of security related toxins. She commented that the list is consistent with other lists of high priority toxins. Dr Bossée further reported that the group is still reviewing data collections on low molecular weight toxins. Additionally, they are still considering other molecules of biological origin that may be relevant, such as bioregulators.
- 4.12 The group discussed the possibilities of how to properly share the information related to the list of security-relevant toxins that should be considered by the OPCW. Additional toxins are unlikely to be added to the Annex on Chemicals to the Chemical Weapons Convention. While this list could be made available publicly, the detailed criteria and assessment used in drawing it up should be considered sensitive. In addition, a separate annex could be created for the final report that contains the full list and evaluation criteria. The access to this information will be determined by the OPCW.

Subgroup 3

- 4.13 Dr Kalb (subgroup co-leader) summarised their group's ongoing work. They recently had an extensive discussion on specific techniques such as enzyme-linked immunosorbent assay (ELISA) and other immunoaffinity methods and the need for more information/better characterisation of such techniques. For many of the toxins, appropriate analytical techniques can be categorised into three areas: immunoaffinity-based, mass spectrometry-based and activity-based. Another way to classify techniques may be by categories of biological, physical and immunoaffinity-based techniques. Each laboratory performing analysis would choose two orthogonal techniques based on different scientific principles in order to appropriately analyse a sample. The question arose whether such an approach would work – would an activity assay and an immunoaffinity assay be trusted without mass spectrometry data? Conversely, for unequivocal identification of a protein toxin, is more than mass spectrometry needed?
- 4.14 It was discussed whether techniques other than mass spectrometry, such as Raman or infrared spectroscopy, are useful or needed. There was also consideration of the use of orthogonal techniques, which could be important and valuable. A relevant example of where this is important is for aflatoxins where immunoaffinity columns are directed against aflatoxin and its derivatives while mass spectrometry gives information on

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<https://www.un.org/disarmament/wmd/secretary-general-mechanism/>.

which one is present. The subgroup proposed to consider making a recommendation related to how to allow for the combination of techniques, with one possibility being to suggest mass spectrometry for sequence information and then using immunoaffinity techniques and/or activity assays to give robust identification.

- 4.15 Rather than listing the pros and cons of different techniques the subgroup feels it is safer and more appropriate to list the different attributes of toxins they would want to know about in any investigation of their alleged use. The subgroup agreed that ricin may be good as a test candidate, a first example, to see how the tables may come together. The current OPCW requirements for ricin analysis include some type of activity assay. However, it was pointed out that ELISA versus liquid chromatography with tandem mass spectrometry (LC-MS/MS) techniques and the current reporting criteria should be revisited depending on characterisation of the antibodies used. Some ELISAs should be granted more points depending on how specific they are.
- 4.16 The TWG discussed when toxin analysis might be needed in the real world by the OPCW. It might be in the form of a request from a State Party that suspects an attack by another State Party has taken place. However, it might be connected to a non-State actor event. The OPCW can also be asked to provide advice or assistance to a State Party on analysis and investigation in support of a suspected toxin incident. Information from sample analysis, such as quantity, activity, functionality, nature of the effects – these are all questions that would likely be important in any investigation. The analytical techniques or approaches recommended should relate to these types of questions and needs.
- 4.17 Different considerations and approaches were then discussed by the whole group, including a reiteration of the need for orthogonal analysis techniques, including levels of certainties for each technique, and so forth. It was concluded there is a need to somehow combine the more traditional world of spectrometry with biological diagnostics based on antibodies, immunoassays, etc. This might necessitate new approaches to equipping laboratories as there are not many labs that can do everything.

Subgroup 4

- 4.18 Subgroup leader, Dr Dorner, recalled that an investigation into an alleged use of a toxin can be potentially launched under the auspice of either the Chemical Weapons Convention (the Convention) or the Biological Weapons Convention (BWC). Under the Convention, the investigation would be conducted by the OPCW, with samples analysed in designated laboratories. In an investigation of alleged use, the focus of the mandate would be on whether a biotoxin had been used as a weapon, and not on who was responsible. Under the BWC, the situation is more complicated as there is no comparable implementing body. However, the scope of the UNSGM is wider than that of the Convention and includes chemical, bacteriological, and toxin weapons and the mandate to consider attribution could be present if decided by the UNSG. The UNSGM is based on three pillars: expert consultants, qualified experts and analytical laboratories, all chosen by the UNSG. Efforts to develop analytical capabilities are currently underway through several laboratory networks. The tasks of analytical laboratories are stipulated under UN General Assembly document A/44/561 and include identification of chemical, biological and toxin agents; determining characteristic impurities and degradation products; validation of preliminary analyses;

elucidating the nature of unknown chemical or biological threat agents; timely preparation and transmission of a report of the results to the UNSG; and participation in interlaboratory calibration studies and source attribution. Because of the overlap with OPCW procedures and guidelines, the subgroup is considering the following recommendations:

- (a) The scope of biotoxins most relevant for each investigative mechanism should be identified, perhaps leading to a subdivision of labour;
- (b) appropriate and common standards and procedures of lab analysis for biotoxins considering their identity, biological activity and quantity should be identified;
- (c) reporting criteria and reporting formats should be defined and harmonised so that they are acceptable under both mechanisms, considering peculiarities of biotoxins; and
- (d) guidelines for selecting laboratories to conduct analyses of biotoxins under the OPCW and UNSGM should be specified so that laboratories are acceptable to both to ensure that results can be used under both regimes.

4.19 Dr Dorner concluded that a common approach on these issues would greatly benefit both mechanisms, therefore one of the TWG recommendations could be that an OPCW-UNSGM working group should be established to work on technical details in the future. One of such group's tasks could be to define performance criteria for laboratory methods other than mass spectrometry. How to identify laboratories qualified to conduct such analysis has not yet been established. Under UNSGM, expert consultants appointed by the UNSG would probably go to External Quality Assurance Exercises (EQAE) results and select appropriate laboratories. This is a different approach from the OPCW that relies on designated laboratories for the analysis of classical chemical warfare agents in environmental and biomedical samples with proven capabilities. It may also be beneficial for the OPCW to have a designation for biotoxins, however which biotoxins (high molecular versus low molecular weight) and which labs would be qualified to analyse such samples is an outstanding question. Therefore, it would be good if the OPCW and the UNSGM could work together as it would benefit both mechanisms.

4.20 It was noted that more information is still needed relating to other national and international authorities. Dr Dorner suggested drafting a table including the available input on relevant national legislation and send to all TWG members to include information related to their respective countries. She also suggested including reference to limitations of EU laboratories in the food and feed sector.

4.21 The conversation turned to question 5f of the group's terms of reference. Dr Dorner noted a couple of considerations, including on the quality system requirements for the laboratories that should be in place (e.g., consideration of ISO 17025 for OPCW Designated Labs); and on how the analytical exercises can be harmonised whilst yet remain flexible to address new or emerging biotoxin threats. Since 2012, there have been several international efforts to develop analytical capabilities in the field of biotoxins through different lab networks and experimental exercises, many of these related to UNSGM or OPCW efforts. They have a related but not identical focus in terms of toxins targeted (OPCW focuses on Schedule 1, others go beyond), and scope

of analysis (qualitative/quantitative, result reporting and geographical representation). To make best use of the expertise developed under different networks, the participating labs should work at least under coherent quality assurances procedures. Currently, only a small number (10-35%) of those labs is accredited under international standards for biotoxin analyses (ISO/IEC 17025 for environmental samples and ISO 15189 for medical laboratories for clinical samples) and ISO/IEC 17043 offering interlaboratory exercises. Generally, accreditation according to national/international standards is important to document the analytical performance since only comprehensively validated methods can be used under an overarching quality management system. It is even more important when thinking about the credibility of results in a political context, (such as the OPCW and the UNSGM investigations). However, she noted that the number of biotoxins is so great that it is unlikely that an individual lab will have tailored and accredited methods for the entire range. Therefore, more flexibility might be needed as too restrictive guidelines could be counterproductive, especially when new or emerging biotoxin threats are suspected in an attack. Furthermore, if quality assurance requirements are set too narrowly, applying new or improved approaches in the case of an alleged use of a novel biotoxin can be difficult. The suggestion would be that participating labs should conduct their work under an overarching quality mechanism (QM) system ensuring regular QM measures. The exact procedure applied in the investigation should be technically robust and should have been published in a peer-reviewed international journal, with accreditation of the specific method to be applied in the investigation not being absolutely necessary as long as the lab works under an overarching QM.

- 4.22 Overall, the goal should be to harmonise those approaches to build capacities for forensic analysis of a broad range of toxins that can be utilised by the OPCW, the UNSGM and other international and national investigative authorities. It is therefore suggested to have an informal coordination mechanism for toxin analysis exercises, i.e., an informal working group, that includes experts from different networks who would meet once to twice a year to exchange information on planned activities, lessons learned and assessment of needs, and to coordinate on issues such as compatible report formatting, common ISO standards, measurement guidelines and transparency about analytical procedures used.

Subgroup 5

- 4.23 Dr Mikulak (subgroup leader) recalled the task of the subgroup. Again, the idea of an OPCW-UNSGM working group to develop some of the technical aspects of toxin analysis was suggested. However, the mechanism by which the working group operates needs further consideration (would it need to be formalised or not?). It needs to be explored on both sides if any agreement needs to be formalised or not.
- 4.24 It was noted that there is a plan under the ongoing RefBio project to initiate an advisory group to help develop reporting criteria,² in particular on high molecular weight toxins, and reporting formats under the UNSGM. The group noted the importance of OPCW being involved in these efforts and suggested recommending the Organisation to review reporting criteria for toxins, including the point system used and whether it is needed at all. It was suggested that current reporting criteria are much more stringent for

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https://www.rki.de/EN/Content/Institute/International/Biological_Security/RefBio.html.

biotoxins than for the classical chemical warfare agents (combination of ELISA, LC-MS/MS, and activity assays). Also, the scoring for different techniques should be re-evaluated as newer ELISA approaches are considerably better than they were before.

5. AGENDA ITEM FIVE – The role of forensics in the support of the attribution process

- 5.1 Dr Robert Bull (forensic examiner, United States of America Federal Bureau of Investigation (FBI) Laboratory) briefly introduced himself and his role as a forensic examiner at the FBI laboratory. He noted that the laboratory's role is neutral in the legal process – it conducts forensic analysis to provide facts, context and leads to the investigation process and forensic itself is not proof, it requires context. He underlined that, when analysing for a chemical or biological agent, their job is to just state whether an agent is there or not, without making any conclusions on how it got there or where it came from.
- 5.2 Dr Bull then provided an overview of forensic analysis conducted by the FBI laboratory in support to the investigative process, where a lot relies on traditional forensics to provide a lead to investigators. In the lab, they always stay within the limits of their accreditation and validation. Some of the forensic disciplines applied in a given case may include latent prints, questioned documents, computer forensics, general chemistry, firearms and toolmarks, trace evidence, human DNA, explosives, CBRN forensics. He noted that it is not unusual to have up to 20 laboratory reports for a particular investigation and it is important that each individual examination stand on its own. With CBRN forensics, one has to be even more careful as the analysis needs to answer the material question to the case. In a toxin case, relevance comes down to if the toxin is there and if there are any other materials present in the matrix of the sample that informs you how it was made or where it came from. All analysis needs to be empirically testable, be able to be subjected to peer review and publication, have known error rates, include the appropriate standards, note the appropriate limitations, and be a theory and technique that is generally accepted by a relevant scientific community. The OPCW has been very helpful in some of these guides; the Organisation has provided guidance on proteomics associated with ricin that has been very helpful.
- 5.3 Dr Bull then provided an overview and some of the intricacies involved with four different FBI investigations, each of them focused on the use of a toxin or biological agent. He outlined some of the important factors, from a scientific/analysis point of view, in each of the cases and shared some of the interesting nuances that showed the complexity of bringing CBRN/WMD cases to court.
- 5.4 There was a question from the group as to which type of analysis the FBI Laboratory uses for toxin analysis; do they just use ELISA or is mass spectrometry also used? Dr Bull started by explaining that irrelevant of the method used they have to ensure that it can stand alone independently as this is an important factor when considering its acceptance and defence in court. He also noted that when using ELISA they have a number of controls in place to ensure they see the toxin in the matrix and make sure that the matrix will not muddle the utility of the activity assay. They have seen matrix issues in the past that can mask things even when the toxin is present.

- 5.5 It was then asked when enough is enough when it comes to evidence collection and analysis (in view of not only resources needed, but a greater likelihood of the defence trying to capitalise on less robust evidence). Dr Bull explained that the FBI laboratory does not decide on the amount of evidence collected, but this is decided by investigators, court and potentially even the defendant. The FBI laboratory's strategy is to make sure that, even in instances where a large number of examiners are working on the same case and the same pieces of evidence, the reports are robust, impartial and defensible.
- 5.6 The group asked whether it is still considered a crime if a toxin is rendered inactive. Dr Bull replied that, from his perspective, it is irrelevant. Their job is to report the facts to the court of if the toxin is active, is it present and is it unfolded. They don't speculate on potential ramifications if in fact an inactive toxin was used.
- 5.7 Dr Bull further gave an overview of the analytical process they follow. They start with samples (dirt, swabs, flasks, powder, or information), followed by sample characterisation (real-time MDA, DNA detection, general protein detection, Raman spectroscopy, x-ray spectroscopy) to see which analytical process to pursue. Samples are then fractionated and from there sample components are taken through different analytical processes such as electron microscopy, immunology assays, activity assays, PCR assays, genotyping, etc. Each case is unique and the choice of method is directed by the needs of the case. The decision to conduct a specific analysis is done by the laboratory and not necessarily by the law enforcement.
- 5.8 Dr Bull also pointed out some additional considerations for the OPCW, including which data are in the report versus what are in supporting documentation. He noted that sequencing data could total more than a terabyte of data. He specified a need to define the role for laboratories in the investigation process and how expert opinions can and should be incorporated.
- 5.9 The group also asked how the FBI laboratory decides when analysis of a sample is finished. Dr Bull explained that FBI practice is to start with the least destructive analysis and move towards the most destructive analysis. From his experience, DNA analysis is in most cases a good place to start. He provided an example where they may be asked to look into an unknown sample; they start with a microscopic examination and based on that decide on the analytical process.

6. AGENDA ITEM SIX – Next steps

- 6.1 The TWG Chairperson commended the productive discussion during the fourth meeting, noting that the TWG has made significant progress in answering the questions posed by the Director-General.
- 6.2 Turning to the possible dates of the next TWG meeting, the SAB Secretary noted that he would contact the TWG Chairperson and Vice-Chairperson in the coming weeks to discuss suitable options for the next two meetings and will send out an online poll to all members to identify their preferences. He noted that they will plan to hold both meetings in person.

7. AGENDA ITEM SEVEN – Any other business

- 7.1 Dr Daan Noort, the Chairperson of the TWG, announced that this will be the last time that he is chairing a meeting of the TWG as he has been appointed the new Head of the OPCW Laboratory. He is therefore unable to continue to serve on the SAB and must step down from both the SAB and this TWG. He expressed his appreciation to the team for all their hard work and looks forward to joining future meetings of the TWG as an observer.
- 7.2 The SAB Secretary thanked Dr Noort for his service as Chairperson of the TWG and noted that the Director-General, after receiving a recommendation from the SAB Chairperson, will be appointing a new Chairperson soon.

8. AGENDA ITEM EIGHT – Closure of the meeting

- 8.1 The Chairperson ended the meeting at 17:25 on 31 March 2022.

ACKNOWLEDGEMENTS

The TWG members thank the guests and members of the Technical Secretariat who participated in discussions. The TWG also wishes to acknowledge Ms Ernesa Ademagić of the OPCW Office of Strategy and Policy for her support and contributions to the meeting and its preparations. Lastly, the TWG thanks the OPCW Director-General for his establishment and support of the TWG and acknowledges the generous contribution of the European Union that helps to cover the costs of the Group's work.

Annex: List of Participants at the Fourth Meeting of the Scientific Advisory Board's Temporary Working Group on the Analysis of Biotoxins

Annex 1**LIST OF PARTICIPANTS AT THE FOURTH MEETING OF THE SCIENTIFIC
ADVISORY BOARD'S TEMPORARY WORKING GROUP ON THE ANALYSIS OF
BIOTOXINS**

	TWG Member	Institution
1.	Dr Isel Pascual Alonso	University of Havana, Cuba
2.	Dr Crister Åstot*	Swedish Defence Research Agency (FOI), Umeå, Sweden
3.	Dr Anne Bossée*	DGA CBRN Defence, France
4.	Dr Graeme Clark	Defence Science and Technology Laboratory, Porton Down, Salisbury, United Kingdom
5.	Dr Cindi Corbett	National Microbiology Laboratory, Public Health Agency of Canada
6.	Dr Christophe Curty	Spiez Laboratory, Switzerland
7.	Dr Brigitte Dorner	Robert Koch Institute, Germany
8.	Dr Mostafa Ghanei*	Baqiyatallah University of Medical Sciences, Islamic Republic of Iran
9.	Dr Suzy Kalb ²	Centers for Disease Control and Prevention, United States of America
10.	Dr Zrinka Kovarik	Institute for Medical Research and Occupational Health, Croatia
11.	Dr Andrea Leisewitz* ⁴	Universidad San Sebastián, Chile
12.	Dr Robert Mikulak	Department of State, United States of America
13.	Dr Daan Noort* ¹	TNO, Netherlands
14.	Dr Yulia Polyak	Russian Academy of Sciences, Russian Federation
15.	Mr Günter Povoden* ³	CBRN Defence Centre, Ministry of Defence, Austria
16.	Dr Fengxia Sun*	Hebei University of Science and Technology, People's Republic of China
	External Speakers	Institution
17.	Dr Robert Bull	Federal Bureau of Investigation, United States of America
	Technical Secretariat Staff	Division
18.	Dr Peter Hotchkiss	Office of Strategy and Policy
19.	Dr Timothy Wood	OPCW Laboratory

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