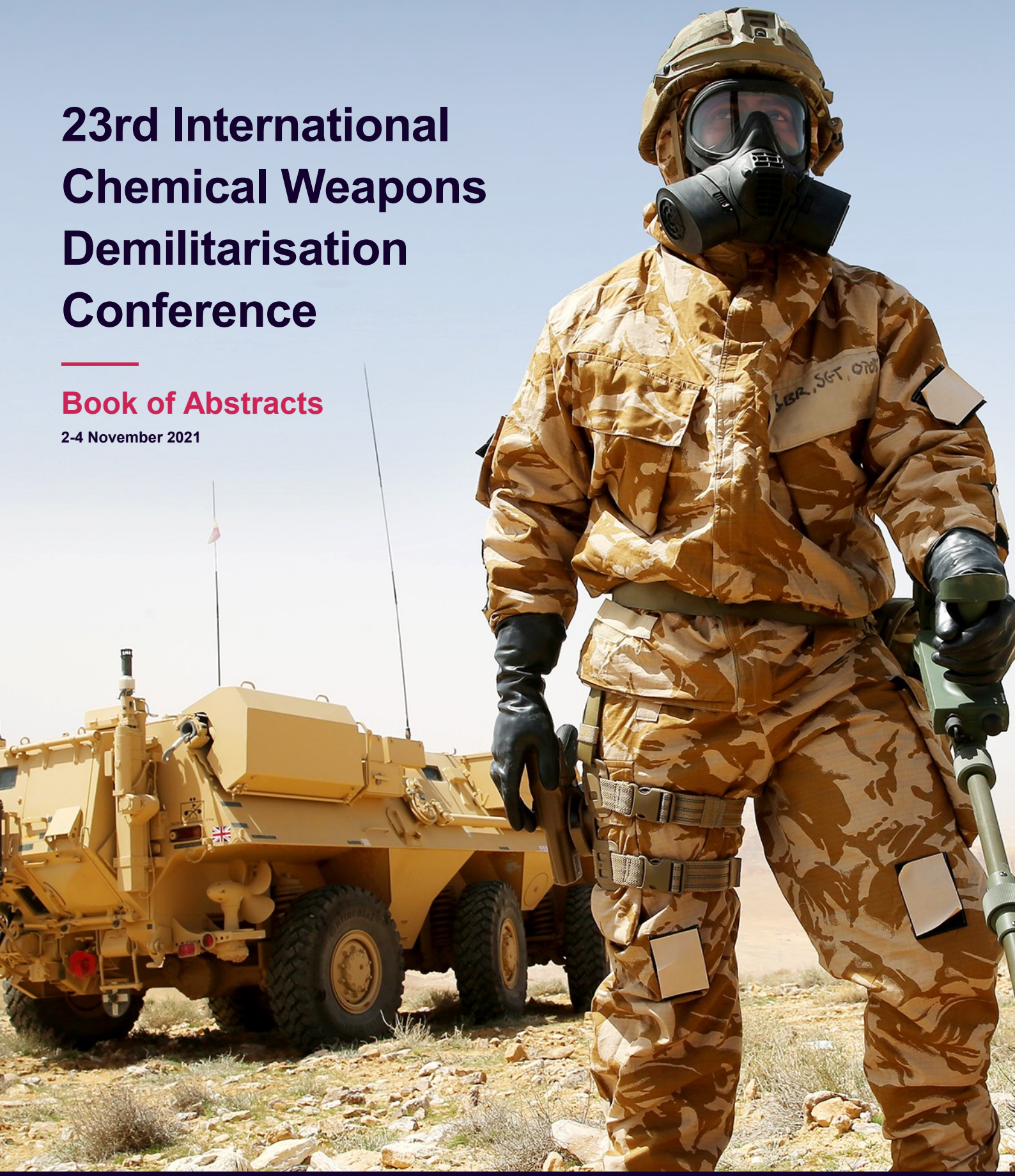
CWD CHEMICAL WEAPONS DEMILITARISATION

23rd International Chemical Weapons Demilitarisation Conference

Book of Abstracts

2-4 November 2021



[dstl] The Science Inside

Ministry of Defence

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Welcome

Welcome to the 23rd International Chemical Weapons Demilitarisation (CWD) Conference. This is organised by Dstl, on behalf of the Ministry of Defence, to promote cooperation and collaborative working to achieve a future free from chemical weapons.

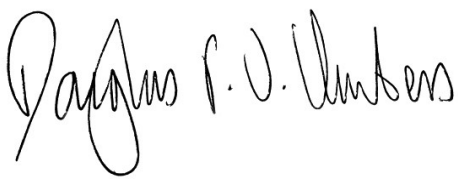
It was disappointing that, for the first time in the long history of the Conference, we had to cancel CWD 2020 due to COVID-19. The continued uncertainty around hosting a major in-person event, and particularly around international travel, has meant that holding CWD 2021 in person was not possible this year either.

However, I am delighted that CWD 2021 is able to go ahead as a virtual event and is providing our delegates an opportunity to meet. Holding the conference virtually has many benefits – we have been able to reach out to a far wider audience than our traditional event allows. The virtual platform also means that delegates can watch the content on demand – any presentations you missed live, or would like to see again, can be viewed on the platform until 3 December.

Despite the global pandemic, chemical weapons destruction has continued and CWD 2021 brings you a programme packed with technical presentations and updates on progress. For the first time, there are also sessions dedicated to emerging risks and chemical forensics and analysis. I hope that you will leave the Conference with a greater understanding of the work undertaken in the chemical weapons demilitarisation field, the many challenges faced and some of the exciting, novel solutions being developed.

We received a record number of abstract submissions for CWD 2021 and, due to the time constraints associated with a virtual conference, some of these will be presented at CWD 2022 instead. Development of the programme is already well-advanced, and although the time between the conferences is reduced, CWD 2022 is already promising to be a great event.

On behalf of the organisers, I would like to thank you for your support of the Conference and for joining us this year on our virtual platform. The pandemic has kept us apart, but we look forward to finally welcoming you all back to London next May – in person! The venue is already booked for 17 to 19 May 2022.



Doug Umbers

Interim Chief Executive

U.S. Marine Corps photo by Sgt. Adam Dublinske

Acknowledgements

Acknowledgements

We would like to thank all our delegates for your engagement and support, which have been instrumental in the continued success of the CWD Conference. We would also like to acknowledge the following organisations for their contributions:

- Organisation for the Prohibition of Chemical Weapons (OPCW)
- Ministry of Defence (UK) and in particular the Counter Proliferation and Arms Control Centre
- U.S. Department of Defense
- U.S. Department of State
- Abandoned Chemical Weapons (ACW) Office, Japan
- Foreign, Commonwealth and Development Office (UK)
- Dstl

Sponsorship also contributes significantly to our success. We are grateful to a number of organisations who have provided generous sponsorship to CWD 2021. Information on this year's sponsors may be found in the Sponsors section.

U.S. Air National Guard photo by Staff Sgt. Patrick Evenson

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Progress on Chemical Weapons Destruction

Sven Devroe

Organisation for the Prohibition of Chemical Weapons (OPCW)

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As of 30 September 2021, the overall amount of chemical weapons verified as destroyed reached 71,476 MTs, or 98.85% of the declared chemical weapons. To date, out of eight Chemical Weapons possessor States Parties, seven have completed the destruction of their declared stockpile. The United States of America plans to complete the destruction of their remaining 2.98% of its declared Category 1 chemical weapons by 2023. Moreover, all former declared Chemical Weapons Production Facilities have either been destroyed or converted for purposes not prohibited by the Convention.

The recovery and destruction of Old and Abandoned Chemical Weapons continues in a number of States Parties.

The destruction of chemical weapons, old or otherwise, is an enormous task, which involves many technical challenges and huge financial expenditure. Safety standards and the protection of the environment, as set forth in the Convention, are paramount.

The achievements realised so far underscore the value of the Chemical Weapons Convention as an effective instrument for promoting the objectives of international peace and security, and as an instrument whose goals are indeed achievable.

To date, 193 States have committed to the CWC and only four countries have yet to join. Even as the destruction of declared chemical weapon stockpiles near completion, universality remains critical to preventing the re-emergence of chemical weapons. The OPCW must remain ready to provide appropriate verification measures in case any new State Party joins the Convention as a possessor state.

This presentation will also touch on how the Secretariat manages the retention of its unique knowledge and expertise on chemical weapons and chemical demilitarisation.

Sven Devroe is a former Belgian Explosive Ordnance Disposal Officer. He was initially appointed as commander of the Old Chemical Weapons (OCW) facility at Poelkapelle, Belgium and was later assigned as CBRNe operations officer. Sven joined the Organisation for the Prohibition of Chemical Weapons in 2016 as Senior Chemical Demilitarisation Officer, dealing mainly with Old and Abandoned Chemical Weapons. He later managed the Chemical Demilitarisation Inspection Cell and was recently appointed as Head of the Chemical Demilitarisation Branch which oversees all chemical weapons technical and verification-related aspects.

PEO ACWA Program Update

Michael Abaie

Program Executive Office, Assembled Chemical Weapons Alternatives (PEO ACWA)

The Program Executive Office, Assembled Chemical Weapons Alternatives (PEO ACWA), continues to focus on honoring the United States' commitment to destroy its remaining 10 percent of the original chemical weapons stockpile inventory. This state of the program overview will describe the status of the Pueblo Chemical Agent-Destruction Pilot Plant (PCAPP) in Colorado and the Blue Grass Chemical Agent-Destruction Pilot Plant (BGCAPP) in Kentucky.

In 2020, workers at PCAPP and BGCAPP achieved significant milestones while weathering the challenges presented by the COVID-19 pandemic. Our partners at the Centers for Disease Control and Prevention provide continual guidance throughout the pandemic to minimize risk to the workforce and the local community.

On Feb. 26, 2020, workers at PCAPP attained the significant milestone of having destroyed more than half the mustard agent in obsolete chemical munitions stored at the U.S. Army Pueblo Chemical Depot. On June 23, 2020, baseline reconfiguration of 4.2-inch mortar rounds containing mustard agent was completed. Assembly of three Static Detonation Chamber (SDC) units - built to destroy 4.2-inch mortar rounds and problematic munitions at PCAPP - was completed on July 20, 2020. Initial testing is underway on the units, as employees from Dynasafe, the manufacturer of the three destruction units, performed a site acceptance test, one of the first steps toward the units becoming operational. The first munitions destruction campaign at PCAPP was completed Sept. 5, 2020, eliminating nearly 300,000 155mm projectiles from the chemical weapons stockpile in Colorado. On Dec. 11, 2020, the 105mm projectile campaign began at PCAPP - the second and final main plant destruction campaign.

The main plant operations phase at the BGCAPP began on Jan. 17, 2020, with the destruction of the first 8-inch projectile containing GB nerve agent. At BGCAPP, the main plant is using neutralization to destroy

PEO ACWA Program Update

Michael Abaie

Program Executive Office, Assembled Chemical Weapons Alternatives (PEO ACWA)

nerve agent munitions. A significant decision was made to not use the supercritical water oxidation system to process hydrolysate, the product of the neutralization process. This secondary waste will be shipped to a licensed and permitted hazardous waste treatment, storage and disposal facility. On May 11, 2020, workers at the BGCAPP completed destruction of all 8-inch projectiles containing GB nerve agent. On Jan. 10, 2021, BGCAPP began destruction of the VX 155mm projectiles. An SDC continues to destroy the Levenstein mustard agent munitions stockpile, scheduled for completion this summer. An additional larger SDC is being installed and will be used to destroy a portion of the nerve agent munitions, including M55 rocket overpacks and rocket components.

Additionally, PEO ACWA reached a significant mission milestone on June 20, 2020, with 50% of the remaining U.S. chemical weapons stockpile destroyed - a combined 1,568 U.S. tons in Colorado and Kentucky.

Michael S. Abaie is the Program Executive Officer for the Program Executive Office, Assembled Chemical Weapons Alternatives (PEO ACWA), which is headquartered at Aberdeen Proving Ground, Maryland.

Mr. Abaie assumed the role of PEO in September 2018 and is responsible for overseeing all aspects of the program, including operations at the Pueblo Chemical Agent-Destruction Pilot Plant in Colorado, the Blue Grass Chemical Agent-Destruction Pilot Plant in Kentucky and PEO ACWA's Anniston Field Office in Alabama. He is a member of the Senior Executive Service.

Japan's ACW Destruction Projects in China - Progress and Challenges Ahead

Hironori Hara
Abandoned Chemical Weapons Office, Japan

In accordance with the Chemical Weapons Convention (CWC), the Government of Japan is making its best efforts to destroy chemical weapons abandoned in China in line with the current destruction plan.

Most abandoned chemical weapons (ACW) found in China are highly corroded or deformed as they have remained under soil or sometimes under water for over 70 years. Therefore, it requires extra caution and care throughout the entire process of excavation, identification, recovery and destruction. Also, since it is a joint project carried out on Chinese soil, there exist various challenges including in terms of legal framework, business custom and government administrative process. All of these factors make the ACW project in China one of the most complicated and challenging chemical weapon destruction projects in the world.

Despite all these challenges, Japan and China have made significant progress in this joint endeavor in recent years. To date, more than 83,000 ACWs have been recovered at various locations in China, out of which nearly 57,000 ACWs have been destroyed. In Harbin, the destruction operations using Mobile Destruction Facility (MDF) started in May 2019, while preparation for the destruction operation in Taiyuan and Guangzhou are being accelerated to deploy Highly Mobile Destruction Facility (HMDF).

In Haerbaling, where the largest concentration of ACWs has been buried, destruction operation using two destruction facilities, namely Controlled Detonation Chamber and Static Detonation Chamber, has been ongoing since 2014. To accelerate the ACW destruction in Haerbaling, a new destruction facility equipped with 4 large scale chambers will be installed in addition to the existing two facilities.

Year 2020 had been challenging to achieve further progress of the project. By the effect of Covid-19 global pandemic, ACW destruction operations have been postponed since the beginning of the year. Amidst these difficult circumstances, Japan has been closely consulting with China and taking actions to prepare for the

Japan's ACW Destruction Projects in China - Progress and Challenges Ahead

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possible resumption of the projects, giving at the same time, due consideration of the effect of pandemic. Although the overall progress of the project has been hindered by the pandemic through the year 2020, the construction for the introduction of new large- scale destruction facilities in Haerbaling resumed in June, and ACW transportation operation was conducted to ensure future destruction. Also small number of experts have been dispatched to the destruction sites in Harbin and Haerbaling late December for the maintenance of existing destruction facilities. Japan continues to make every efforts to minimize its impact and advance the project as much as possible.

Along with making its utmost effort to destroy ACWs, Japan assigns the highest priority to ensuring the safety of people and protection of the environment in accordance with CWC.

2011-2013	*Officer for public relations, Official Development Assistance Division, Ministry of Foreign Affairs*
2013-2017	*Officer for press release, Press Division, Ministry of Foreign Affairs*
2017– present	*Officer for external communication, Abandoned Chemical Weapons Office, Cabinet Office*

Destruction of Japanese Abandoned Chemical Weapons: Progress and Challenges

Jiwei Liu

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Japanese Abandoned Chemical Weapons (JACWs) have been discovered at more than 90 locations in 17 provinces across China. JACWs have been seriously threatening and endangering the lives and property of people and the ecological and environmental security in relevant areas of China. In accordance with the provisions of the CWC, Japan is obliged to destroy JACWs, China will provide appropriate cooperation. China and Japan have conducted bilateral on-site investigations at more than 170 sites since 1995, which resulted in the recovery of nearly 86,000 JACWs. Haerbaling is the largest JACWs burial site discovered so far, where estimated 330,000 JACWs buried according to the bilateral investigations' results.

Progress has been made on the destruction of JACWs during the year of 2019. Three destruction operations were conducted at Haerbaling destruction facility with total of 3251 JACWs destroyed. In the meantime, three excavation operations recovered 8240 JACWs at Haerbaling burial site. The Haerbin Mobile Destruction Facility became operational in May 2019. There were 2 destruction operations at Haerbin with 1828 JACWs destroyed. 9 bilateral investigation, excavation or identification operations at 7 different locations were conducted with 4108 JACWs discovered.

OPCW consistently attached great importance to the issue of destruction of JACWs discovered in China and conducted 12 on-site inspections in 6 missions at 8 different JACW storage, destruction or excavation sites. China, Japan and the Technical Secretariat of the OPCW held 5 rounds of trilateral consultations on the issue of JACWs since June 2019.

We are facing many challenges before the completion of the JACWs destruction in line with the provisions of the CWC and relevant decision of the Executive Council.

Mr. Jiwei LIU is an official of the Office for the Disposal of Japanese Abandoned Chemical Weapons (JACW) at the Ministry of National Defence of the People's Republic of China. He is responsible for the issues related to the disposal of the Japanese Abandoned Chemical Weapons discovered in China and other issues related to the implementation of the CWC.

Implementation of the Rocket Warhead Containerization System (RWCS) at the Blue Grass Chemical Agent-Destruction Pilot Plant (BGCAPP)

Timothy Garrett

Program Executive Office, Assembled Chemical Weapons Alternatives (PEO ACWA)

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The Program Executive Office, Assembled Chemical Weapons Alternatives (PEO ACWA) designed a new rocket processing strategy for GB and VX 115mm (M55) rockets at the BGCAPP. Safety considerations with the neutralization / supercritical water oxidation (SCWO) process prompted the implementation of the Rocket Warhead Containerization System (RWCS) at the BGCAPP. This process uses various remotely-controlled robots and conveyor systems to move the rockets through the various components of the new rocket processing system.

After the chemical agent has been drained from the warhead at the punch and drain station, which is part of the original rocket processing design, the warhead is containerized in a specially- designed steel canister that is sealed using a hydraulic press to prevent a chemical agent vapor leak. The canister is palletized, monitored and placed into a storage igloo until destruction in the SDC. The warhead does not require removal from the canister prior to destruction. The containers are moved from the storage igloo and fed directly to the SDC, which increases worker safety. This presentation will discuss the intricacies of the RWCS and the testing that has been performed to date.

Timothy K. Garrett is the Director of Field Operations for the Program Executive Office for Assembled Chemical Weapons Alternatives (PEO ACWA). He provides oversight of Static Detonation Chamber operations ensuring Army, State, and Federal safety and security standards and environmental laws, regulations, and permit conditions are maintained. Mr. Garrett is also charged with effectively implementing ACWA's strategic goals. Another critical role involves providing chemical agent munitions and agent destruction managerial and technical support to the chemical demilitarization disposal facilities in Colorado and Kentucky.
Mr. Garrett's previous assignment was as the Site Project Manager for the Anniston Chemical Agent Disposal Facility (ANCDF) at the Anniston Army Depot. The facility was designed and constructed to safely and efficiently destroy 2,254 tons of chemical agents (GB, VX, and Mustard) in munitions stored at the Anniston Army Depot.
ANCDF was operational from August 2003 until September 2011. The team of government and contractor employees at the ANCDF that Mr. Garrett managed and mentored for 13 years safely demilitarized 661,529 munitions and 2,254 tons of nerve and mustard agents. The GB nerve agent campaign concluded in March 2006. The VX nerve agent campaign concluded in December 2008. The Mustard agent campaign was completed in September 2011, marking the end of disposal operations.
Mr. Garrett, a licensed Professional Engineer and has a Bachelor of Science Degree (1983) in Chemical Engineering from The University of Alabama and a Master of Science Degree (1994) in Environmental Engineering, also from The University of Alabama.

Castalia High Throughput Chemical and Conventional Demilitarization System

Steve Thompson

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Soukos Robots, SA has developed a mobile, high-throughput munition demilitarization system in Larissa, Greece. This system, called Castalia, has been processing a wide range of conventional ammunition in Greece for over 10 years. We have recently re-designed the Castalia system to process chemical filled munitions under contract to the U.S. Joint Project Manager for Protection office and it will be tested in the coming months.

The Castalia is designed to process at least 20 chemical filled munitions per hour, including 155mm projectiles, M56 rocket warheads, and M55 rocket motors. The system uses a combination of mechanical and electro-magnetic (E-M) energies inside a water-based emulsion solution to break open munition bodies, access the chemical agent fill and quickly neutralize the agents by accelerating reactions with the E-M energy. Energetics are desensitized and destroyed in a secondary destruction process.

Laboratory scale testing of the agent neutralization process was verified at The U.S. Army Combat Capabilities Command Chemical Biological Center (DEVCOM CBC) Chemical Biological Application & Risk Reduction (CBARR) laboratories. A small E-M wave generator was used on a series of emulsion solutions, each dosed with one of seven different chemical warfare agents. We demonstrated destroyed GB and L within one minute. HD, H, VX and RVX were destroyed within 5 minutes. All of this was done with an emulsion temperature starting at 25C and reaching a maximum of 60C. In addition, the concentration of agent was much higher than the design concentration in the full scale system. The results of this sub-scale testing verified our ability to quickly destroy these materials and suggests that our destruction efficiency may be much faster than our planned rate for the full scale system.

The Castalia Mk5 system is designed to process both chemical and conventional munitions and is in the final

Castalia High Throughput Chemical and Conventional Demilitarization System

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fabrication steps at a facility in the U.S. Once commissioned, the system will be tested at Aberdeen Proving Ground using test articles filled with agent simulants, warfare agent materials and conventional munitions to verify destruction efficiencies, overall throughput rates, emissions and safety. We believe that the system will be able to achieve a throughput rate of greater than 20 chemical filled rounds per hour and 60 M67 rocket motors per hour based on all of the testing performed to date.

Mr. Thompson has over 20 years' experience in demilitarization of chemical and conventional ammunition and non-proliferation both in the U.S. and internationally. This experience includes developing demilitarization technologies at Naval Surface Warfare Center, Indian Head Division; providing technical and project management support to the Cooperative Threat Reduction (CTR) Program of DTRA for ICBM elimination projects in the former Soviet Union; serving as Operations Manager and then Program Manager for the DTRA SS-24 ICBM and SS-N-20 SLBM elimination projects in Russia and Ukraine; Senior Project Manager for the DTRA Albania Chemical Weapons Elimination Project in Albania; Strategic Operations Manager for stockpile chemical weapons elimination projects in the U.S; and Senior Project Manager for the DOE Second Line of Defense Projects to prevent smuggling of radiological materials in Romania and Poland. Mr. Thompson is currently the Chief Technology Officer for Soukos Robots Demil USA.

DAVINCH Operations Updates 2021

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Kobe Steel has developed a controlled detonation chamber system, DAVINCH, and operated the systems at a number of global sites with exceptional safety performance for over 20 years since the first disposal of Old Chemical Weapons (OCWs) at Lake Kussharo in Japan. Nearly 3,000 sea-dumped WW2 chemical munitions had been safely recovered and destroyed by DAVINCH system at Kanda Port in southern Japan by 2013 then the system was dismantled.

Abandoned Chemical Weapons (ACWs) from the second world war have been destroyed in China since 2010, using DAVINCH systems in Nanjing, Wuhan, Shijiazhuang and Haerbaling. The operation at the first three sites had been completed by 2016. The system used in Nanjing and Wuhan had been decontaminated and brought back to Japan and overhauled. The system was transported and installed in Harbin in northern China and started destroying approximately 6,000 ACWs stored in the area. Destruction at Haerbaling is still ongoing since its commencement in 2014, with temporary breaks in winter. Recently, another larger destruction facility with DAVINCH system and a waste treatment facility are being designed and manufactured for Haerbaling site to accelerate the destruction at this largest ACW burial site in China. The government of Japan has been investigating the ACW storing site in Liaoyuan and Kobe Steel supported the effort in 2019.

In Europe, old chemical weapons and a variety of conventional munitions from the first world war have been destroyed by DAVINCH system in Belgium since 2008. Another DAVINCH facility had been installed for SECOIA program in France and operation was started. In 2020, above all destruction operations had been forcibly stopped by spreads of COVID-19 and the operation in China has not been resumed yet, due to the travel restriction. Currently, we are making efforts to restore equipment to normal condition from a long shutdown and to restart destruction in China while implementing infectious prevention measures.

	Completed master's course at Energy Science, Kyoto University.
2011	*Joined KOBE STEEL.*
2011-2013	*Treatment of wastes from abandoned chemical weapons destruction in China.*
2013-2014	*Dismantling and Relocation of a destruction facility for abandoned chemical weapons in China.*
2015	*Test operations of detection and recovery of river-dumped chemical weapons at Heilongiang, China.*
2015-2016	*Refurbishing of mobile destruction facilities for disposal of abandoned chemical weapons at different locations in China.*
2019	*Destruction of abandoned chemical weapons, operation team manager at Harbin site.*

The Dynasafe Static Detonation Chamber - SDC 2000 C - The New Generation

Thomas Stock, Charles Diggs, Risto Viinikka
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Dynasafe has been manufacturing Static Detonation Chambers (SDC) for over 25 years. Customer requirements have driven new developments on these destruction units. Therefore, Dynasafe has a variety of SDC models for conventional as well as chemical munitions destruction.

Dynasafe also has a proven long-term record for tailor-made Off-Gas Treatment Systems (OTS) accompanying the SDC units downstream to ensure the complete systems (SDC plus OTS) fulfil all relevant norms for superior off-gas cleaning.

Based upon customer requirements a new SDC 2000 C has been designed by Dynasafe within the last 2 years. The focus hereby was to have a large Destruction Chamber (DC) where object lengths up to 2.6 m can be processed. The large inner volume of the DC and the robust design will allow high throughputs of energetic material. In addition, a new locking system with high pressure claws is applied with solid sealings (non-pneumatic) that withstand high detonation loads. It is designed for 8 kg TNT NEQ (tested with 10 kg TNT NEQ gastight according DDESB requirements).

The newly designed system SDC 2000 with the OTS unit has been manufactured and tested during 2020 for a customer project destroying shells, warheads, and complete rockets (overpacked) containing nerve agent chemicals.

The presentation will provide a general overview about the new SDC 2000 C.

As usual for Dynasafe, the SDC comes with an OTS system which will clean the downstream off gases resulting from the destruction process up to the national environmental level for release. In the current application with the new SDC 2000, the OTS consists of various transportable modules/racks which will allow for easy installation. Each unit operation is specialized in the removal of pollutants or fulfilling a specific task in the OTS. The presentation will provide an overview about the downstream off-gas cleaning process in general as well as the particularities.

Dr Thomas Stock, Scientific Expert with DYNASAFE Environmental Systems GmbH. PhD in chemistry. Trained as analytical chemist. Besides the analytical background also knowledge in toxicology questions and decontamination of CW. Working as an expert in chemical disarmament and arms control from 1987-1996 which special focus on old and abandoned CW, dumped CW, destruction and verification technologies. Between 1988 and 1996 Project Leader and Program Manager of the CBW Research Programme at SIPRI (Stockholm International Peace Research Institute). Work focussed on: chemical weapons, old and abandoned chemical weapons, destruction technologies, environmental aspects, waste disposal technologies, and verification techniques and technologies. Since 1996 in private industry in different positions, such as Project Leader and Sales Manager. Since 2002 with DYNASAFE, Swedish born company, as Sales Manager, Project Manager and Managing Director of Dynasafe Environmental Systems and from 2016 until 2019. Since September 2019 retired. Published on various issues of analytical chemistry, arms control and disarmament, old and abandoned CW and CW destruction, environmental relevant issues.

Using Reduction Chemistry for Producing RNG and Hydrogen Fuel from Carbon-Based Waste Materials

Joseph Asahina[1], Theodore Prociv[2], Douglas Hallett[2]

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More than 96% of the stockpiles has been destroyed and large number of ACWs in China is successfully being destroyed by Governments of Japan and China. Will the threats of CW be extinguished or solved with time? Absolutely “No”. The problems we are facing now is far beyond supposition of CWC, that is the threats of terrorism by the non-state-parties.

There are big differences between munitions covered by CWC and chemicals used under new circumstances. The chemicals are:

- dual use industrial chemicals,
- mostly in bulk, without explosives,
- the range is much wider than the Convention’s treat and
- the storage is often located close to the populated area.
- precursors stored in an attempt to avoid treaty restrictions

The big explosion in Beirut, which is fresh in our memories, proved the threat of dual use chemicals, Ammonium Nitrate. Recovery and destruction of non-stockpile is required not for possible threat as potential weapons but for environmental protection.

Therefore, the way of destruction of chemicals, when found, should be different from what we have used or use now under the Convention. When the targets are found in an area of conflict, construction of a facility onsite is difficult and transportation of the targets is exposed another risk of attack.

Considering the situation, we propose Hydrogen Reduction Process (HRP). It is completely different from neutralization or oxidization. “One size fit all solution” does not exist for chemical safety and security.

Using Reduction Chemistry for Producing RNG and Hydrogen Fuel from Carbon-Based Waste Materials

Joseph Asahina[1], Theodore Prociv[2], Douglas Hallett[2]

[1]GP&P Co Ltd, [2]True Energy Incorporated

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However, HRP is best process for dual use industrial chemicals and non-stockpiles of various kinds. Applicable to all kinds of targets, such conversion any organic materials, as mixtures of organic and inorganic materials, as well as ancillary contamination such as soils and infrastructure materiel.

Reduction of environmental impacts:

- no dioxin generated
- no toxic gases released
- no smokestacks necessary
- less amount of secondary waste
- avoiding leachate and toxic water discharge
- no big noise
- high solid reduction rates
- no organic compounds but inert inorganic solids left
- no bottom and fly ash remains
- easy transportation of cleaned solid for recycling

Mobile system:

- a compact system design installed in 20 to 40-foot containers
- easy transportation on land or on the surface
- flexible operation on trucks or on ships

The process description, the past development and operation records over 20 years will be explained by True Energy Incorporated.

Dr. Asahina is President, Senior Scientific Advisor of ICCSS, a member of the Committee of the Science Council of Japan, on Safe Destruction of ACW /OCW, a member of the Special Working Group of ASME and a member of the Japan Society of Defence Facilities Engineers. He was Chief of Technology of Kobe Steel, until 2014, engaged in the main Japanese CWD projects and worldwide in Belgium and French projects for oversight of technical aspect, and proposal works for Tooele USA.

Project Perses

Steve Kennon

Valent Applications

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Valent has been drilling into chemical munitions since its inception in 2000. In the past two decades we have accessed all manner of hazardous containers from munitions to 1 tonne cylinders full of HF, across all parts of the globe. In that time we have built up a great deal of experience and knowledge in what works and what does not. Additionally our almost continual development of new equipment meant we have a 'bank' of technology we can call upon when faced with new challenges.

The idea for Viper came about well before the Don't Blow It! competition. An unrelated team meeting saw us call upon all that stored knowledge to outline the concept for a new device that would offer almost the same capability as our previous equipment but in a small, lightweight and modular system. Although it would involve research and development it would build upon field proven technology which greatly de-risked the project.

Around the same time we heard about some research work been undertaken by Sandia National Laboratories, from the US, in the area of CW destruction. They had successfully demonstrated the effectiveness of lithium nitrate against CW and were now looking to engineer this into a possible field deployable solution.

This sounded ideal as there seemed no point in developing a lightweight access system unless it had lightweight destruction technology to go with it. We made contact and decided to pair our respective technologies and so Project Perses was born.

Steve graduated as a Civil Engineer from Strathclyde University in 1990. Soon after, he joined the British Army as an officer with the Royal Engineers. After a number of operational tours he was team leader of the Royal Engineers bomb disposal teams and Regimental Training Officer.

On leaving the Army he served as a Police Officer, where he was awarded the Baton of Honour before completing his MBA and joining the Hilti Corporation of Switzerland as a Technical Manager. After heading Hilti's Strategic Marketing team in the UK and Ireland he left in 2009 to join Valent Applications as their Head of Business Development and then Operations Director. In those roles he has worked on a number of CBRN projects and has trained military units and CBRN organisations worldwide. Day to day he tries, with his fellow Director, to run, grow and develop the Valent organisation.

Project Blackdog

Steve Kennon
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As discussed in our other abstract on Project Perses, Valent has been drilling into hazardous objects for a long time. Our knowledge of how to do this is recognised as unparalleled and so the Viper system was, to us, the natural evolution of the multiple systems we had developed in the past twenty years. It embodies everything we have learned from our own experience but also from the feedback we have received from dozens of operators from the multiple organisations we have worked with over that time.

Developing a small, lightweight access system was only half the problem however. There seemed little point in building something so useful if it had to be carried with vast drums of conventional decontaminant to destroy the agent. We knew from discussions we had in Don't Blow It Phase 1, that the UK company, PolyCat, had some extremely innovative technology involving coated nano particles. We had already looked at how these might be paired with our existing systems so when Phase 2 called for a complete access and destruction solution working together seemed an ideal partnership. And so Project Blackdog was born (its name comes from the fact I was looking at my black dog when writing our proposal!).

Steve graduated as a Civil Engineer from Strathclyde University in 1990. Soon after, he joined the British Army as an officer with the Royal Engineers. After a number of operational tours he was team leader of the Royal Engineers bomb disposal teams and Regimental Training Officer.

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Toxic Agent Remotely Deployable Incineration System, TARDIS

Ambrose Buchanan

Event Horizon

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The Toxic Agent Remotely Deployable Incineration System (TARDIS) was proposed as a destruction solution in response to the Defence and Security Accelerator's (DASA) Don't Blow It! Phase 2 call for proposals. TARDIS is designed to thermally destroy bulk quantities of chemical warfare agents and their precursors. It is a mobile solution, meeting the Don't Blow It! criteria of fitting on a NATO 463L pallet, and its simple and automated operation results in a low training burden and reduced manpower requirements. This poster presentation will describe the development of the TARDIS system during Phase 2, with a more detailed presentation of the technology planned for CWD 2022.

Explosive engineer with 18 years' experience working on a range of explosive and engineering projects for UK MOD and commercial aviation and defence customers. Extensive understanding of the design to manufacture process, from design initialisation through to delivery to the customer. Long history of working in specialist services to the film industry, including the design and programming of motion-controlled platforms.

Tick-Vampire Man Portable Demilitarization System

Steve Thompson
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The Soukos Robots Team, consisting of Soukos Robots, SA, Soukos Robots Demil USA, and Mountain Horse Solutions is in the process of conduction simulant tests on a man-portable system prototype for accessing, disabling and destroying munitions, IEDs and bulk containers filled with chemical warfare agents found in a tactical environment. This new technology, named Tick-Vampire, was created at the Soukos Robots facility in Larissa, Greece under contract to the UK Defense and Security Accelerator (DASA) through the "Don't Blow It!" industry challenge program.

The Tick-Vampire system is designed for field deployment in two backpacks of no more than 32 pounds each. All components, materials and supplies needed to access, disable and destroy agent filled munitions and small bulk containers will fit into the backpacks. The components that were built and tested include a munition access device; an adjustable bridge device holding the access devices and allowing a one-handed placement on the target; two pumping devices; a static mixer holding reagent; and a control console. Agent will be removed from the munition and mixed with the reagent in such a way to ensure a slow and controlled neutralization reaction occurs with adequate room within the system for exothermic expansion.

Our design is intended to have one soldier attach the munition access device to the item and another will connect the static mixer to the line. Once assembled, the system will operate remotely and automatically to access the agent cavity and start the neutralization cycle which is approximately 20 minutes. Once complete, the neutralized agent and solution remains in the munition, IED or bulk container and the solution cartridge which are left in the field.

We were able to test hardware components and perform rate of reaction testing with CEES and DMMP simulants to verify we have a controlled reaction, an acceptable rate of reaction and to verify the overall system operational time for a large munition.

Mr. Thompson has over 20 years' experience in demilitarization of chemical and conventional ammunition and non-proliferation both in the U.S. and internationally. This experience includes developing demilitarization technologies at Naval Surface Warfare Center, Indian Head Division; providing technical and project management support to the Cooperative Threat Reduction (CTR) Program of DTRA for ICBM elimination projects in the former Soviet Union; serving as Operations Manager and then Program Manager for the DTRA SS-24 ICBM and SS-N-20 SLBM elimination projects in Russia and Ukraine; Senior Project Manager for the DTRA Albania Chemical Weapons Elimination Project in Albania; Strategic Operations Manager for stockpile chemical weapons elimination projects in the U.S; and Senior Project Manager for the DOE Second Line of Defense Projects to prevent smuggling of radiological materials in Romania and Poland. Mr. Thompson is currently the Chief Technology Officer for Soukos Robots Demil USA

Catch the ChemBio SCENT!

Graeme Clark
Dstl

This Defence and Security Accelerator (DASA) competition is seeking proposals that can address challenges associated with screening for, the preservation of sample/evidence, and the attribution of hazardous chemical and biological (ChemBio) materials. New technology options or technical approaches could ultimately help both the successful identification of material and directly/indirectly aid in bringing perpetrators to justice. As well as addressing this diverse set of technical requirements, one of the goals of the “Catch the ChemBio Scent” is to engage with a non-traditional ChemBio supplier base in order to yield innovative solutions.

Professor Graeme Clark is the Project Technical Authority for Biological Analysis and Attribution. He is responsible for maintain existing and developing new capability for the analysis of samples potentially containing hazardous biological materials (e.g. bacteria, virus, toxins). He is an internationally recognised Defence and Security Microbiologist with a deep technical specialism in the field of biological toxins representing Dstl at EU, Organisation for the Prohibition of Chemical Weapons (OPCW) and UN level meetings; helping shape the future of defence and national security policy and strategy.

Sampling and Analysis of Chemical Weapons Using Thermal Desorption GC/MS: Improving Identification, Throughput and Reliability

Caroline Widdowson, Helen Martin

Markes International

cwiddowson@markes.com

The acute toxicity of airborne chemical warfare agents (CWAs) requires sampling and detection systems that can identify trace levels of these compounds, potentially in complex matrices. This is a requirement both at military installations, and more recently for pre-emptive monitoring at key civilian locations. Online and offline methods have been developed and refined over the years, and recent advances in analytical hardware and software have enabled improved identification of compounds, increase workflow/throughput capabilities and greater flexibility in sampling methods.

This presentation describes these advances in sampling and analytical technology for highly sensitive detection and confident identification of CWAs as well as explosives. Systems consist of either online or offline sampling, combined with innovative pre-concentration technology prior to separation by either one- or two-dimensional gas chromatography and detection via quadrupole or time-of-flight mass spectrometry. Online systems can enable continuous near real time analysis of many different environments, for example from mobile laboratories or deployed within civilian infrastructures of high population density, while offline systems can be used for routine screening and quick response to events.

Caroline Widdowson is a specialist in the sampling and analysis of trace organic compounds from a range of environments - Ambient, Indoor and Workplace air, as well as compounds released for products and materials. Caroline received her PhD in Organic Chemistry from Cardiff University and now works at Markes International, an advanced analytical instrumentation company as the Market Development Manager. Caroline is an active member of many standard and regulatory committees, involved in drafting methodology for national and international mandates on Air Quality and Chemical Emissions.

Ultra-sensitive Detection of Chemical Threats by Atmospheric Pressure Chemical Ionization Mass Spectrometry

HJ Jost, Paxton Juuti, Jyri Mikkilä
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We report results achieved with an atmospheric pressure, chemical ionization inlet coupled to a high-resolution time-of-flight mass spectrometer (Tarkka TOF) for sensitive, real-time identification and quantification of gas-phase compounds. We have combined the Tarkka TOF with a sampling chamber and demonstrated the detection of hidden explosives. In this presentation, we discuss the system and potential use for chemical warfare agent detection in general and specifically decontamination control. To verify C decontamination procedures, it is desirable to be able to test complete objects with complex surfaces or threats present on the inside of the devices.

The Tarkka TOF evolved from powerful atmospheric research instrumentation originally developed at the University of Helsinki[1] and has been optimized for the detection of explosives. We have demonstrated the quantitative response over a broad dynamic range down to parts per quadrillion (ppq) gas-phase sensitivity for e.g. RDX, which is significantly below RDX saturation vapour pressure. Limits of detection for explosives range from nanograms to sub-picograms for dissolved standards. The soft ionization combined with high mass resolving power enables molecular and elemental speciation. The high ion duty cycle enables simultaneous measurement of all mass-to-charge ratios and hence analysis of complex chemical signatures with data acquisition rates exceeding 200 complete mass spectra per second. The Tarkka TOF is relatively low power and in a field transportable assembly.

So far we can report the detection of 0.03 picograms of the Sarin simulant dimethyl methylphosphonate (DMMP) with the Tarkka TOF. Literature suggests that other chemical warfare agents can be ionized and be detected with for example Ion Mobility Spectrometry. VX is considered non-volatile, but its vapor pressure is higher than the explosives TNT, and we therefore expect to detect trace amounts present even inside of devices.

HJ Jost received his Ph.D. from the University of Berne in Switzerland in applied physics. He then moved to California and worked initially as a postdoctoral researcher and later as senior scientist on various NASA air- and balloon borne atmospheric research field campaigns all over the world. In 2006 he joined Novawave Technologies, a Silicon Valley start-up focused on developing laser based trace gas analysers, and was director of atmospheric sensing. After the acquisition of Novawave by Thermo Fischer Scientific in 2010, he initially served as a senior manager of R&D and then moved back to Europe where he took a product management role with global responsibilities. In 2016, he helped co-found Karsa Ltd and has been serving as CEO since the beginning.

Truly Hand-held Raman for Chemical Threat Identification Simplicity-Speed-Precision

Johan Raneke

Serstech AB

jr@serstech.com

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Chief Commercial Officer. Responsible for Serstech commercial strategy, global sales and partnerships for the last three years. Twenty-five years of experience from various and leading roles in sales, key account and project management.

Truly handheld Raman for quick chemical threat identification.

Serstech manufactures the smallest, lightest and most cost-effective Raman solutions with ground breaking technology on the market. All substance libraries are developed in-house in cooperation with police and customs around the world and with Swedish Defense Research (FOI). Serstech instruments come with a complimentary and powerful companion software, for fast and correct decision making that meets your needs both in the field and in the office or laboratory

Chemical Security Perspective in Crisis Management: Project STRATEGY

Luís Carvalho, Júlio Gouveia-Carvalho, Tiago Gonçalves, Pedro Neto, Paula Lopes and Wilson Antunes

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The STRATEGY is an EU Horizon 2020 funded project which aims to develop a pan-European framework of the pre-standardisation activities in the crisis management domain. Solutions, tools and procedures for both technical and organisational interoperability in a fully transboundary configuration will be addressed and validated by sustainable tests and evaluation frameworks. Selecting, testing and implementing existing, evolving and new standards will improve the crisis management and disaster resilience capabilities. To achieve such goals STRATEGY consortium integrates standardisation bodies, policy makers, technology suppliers and first responders from several countries across the EU.

Based on previous projects' results and the EU priorities, the STRATEGY is divided in eight different streams: Search and Rescue; Critical Infrastructure Protection; Response Planning; Command and Control; Early Warning and Rapid Damage Assessment; CBRN-E; Training; and Terminology. CBRN-E, along with Training and Terminology, is by definition a horizontal stream as it strongly correlates to all the first five streams.

Selected standards will be tested with the implementation of use cases in the frame of Table Top Exercises (TTX), at least one per stream, and a Full-Scale Exercise (FSX), which will integrate all the streams in a large scale scenario in Italy in 2023.

The CBRN-E stream's TTX will be held in Portugal in 2022.The goal is to test the selected standards under different scenarios, namely Chemical, Biological and Radiological incidents. Those incidents will challenge practitioners to implement in a simulated crisis incident the pre-selected standards under different use cases to understand its applicability, feasibility and suitability. The selected standards will focus standardization gaps on CBRN-E incident management and resolution that were assessed in the early stage of the project.

Chemical Security Perspective in Crisis Management: Project STRATEGY

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On a chemical security perspective, several domains will be addressed, regarding both natural or intentional scenarios: the use of unmanned aerial systems and their data collection for reconnaissance and incident development; sampling strategy and information management system for electronic chain of custody; standards for CBRN-E related terminology and symbology; processes for risk assessment and evolution in real time (e.g. through integration of weather systems data); etc.

STRATEGY's ultimate goal is to strengthen the resilience of EU against disasters, both natural and man-made, by improving first responders' operational capabilities ensuring an effective and efficient collaborative response through validated standards on solutions, tools and procedures.

Luís Miguel Carvalho received the B.Sc. in Chemistry with minor in Biochemistry from the Faculty of Sciences of the University of Lisbon, Portugal (2010) and the M.Sc. in Analytical, Clinical and Forensic Toxicology from the Faculty of Pharmacy of the University of Porto, Portugal (2012). After work in a research project and as salesman and factory production manager in a chemical production company in 2016 he enlisted in the Portuguese Army. Since March 2017 he is assigned to the Military Laboratorial Unit of Biological and Chemical Defence to work both as researcher in the Chemical Defence Laboratory and member of the Chemical Defence Deployable Team. Due to COVID-19 pandemics in March 2020 he was assigned to the Biological Defence Laboratory to integrate the SARS-CoV-2 detection teams. His work and interests are focused in Chemical Weapons and CWC, disarmament and non-proliferation of WMD and international organizations related to those subjects.

The New Face of Chemical Weapons: Where Do We Go From Here?

Rebecca Hersman

Center for Strategic and International Studies (CSIS)

A new chemical weapons landscape has emerged. The willingness of some state and non-state actors to use or acquire chemical weapons appears to have increased, and the potential for state or non-state actors to field CW capabilities is growing rapidly. Unless the international nonproliferation regime can adapt to address the threat of chemical weapons, these concerning trends will almost certainly intensify in the foreseeable future as proliferation networks and emerging technologies with CW implications mature. In 2021, we need to look facts squarely in the face and recognize that traditional concepts and approaches – both military and diplomatic – will not serve us well in meeting future challenges.

Rebecca Hersman is director of the Project on Nuclear Issues (PONI) and senior adviser with the International Security Program at the Center for Strategic and International Studies (CSIS). A leading expert on nuclear, chemical, and biological weapons policy; global health security; and crisis management, Ms. Hersman leads the preeminent national program designed to develop next generation nuclear expertise. An author of numerous studies and reports on nuclear and chemical weapons policy, emerging technologies and strategic stability, and crisis management and decisionmaking, Ms. Hersman also co-chairs the CSIS U.S./UK/France Trilateral Dialogues on Nuclear Issues and has served as a commissioner on the CSIS Commission on Strengthening America's Health Security.

Ms. Hersman joined CSIS in April 2015 from the Department of Defense (DOD), where she served as deputy assistant secretary of defense for countering weapons of mass destruction since 2009. In this capacity, she led DOD policy and strategy to prevent WMD proliferation and use, reduce and eliminate WMD risks, and respond to WMD dangers. She was a key leader on issues ranging from the elimination of Syria's chemical weapons, nuclear response and mitigation during the Fukushima crisis, and WMD interdiction policy and response. Ms. Hersman led DOD engagements on WMD issues with NATO, South Korea, Japan, and others, and also served as DOD's principal policy advocate on WMD arms control, nonproliferation, and threat reduction. Prior to joining DOD, Ms. Hersman was a senior research fellow with the Center for the Study of Weapons of Mass Destruction at the National Defense University from 1998 to 2009. Ms. Hersman previously held positions as an international affairs fellow at the Council on Foreign Relations, a special assistant to the undersecretary of defense for policy, and a member of the House Armed Services Committee professional staff. She holds an M.A. in Arab studies from Georgetown University and a B.A. from Duke University.

Future Trajectories: Geopolitical Scenarios for Future Demilitarisation Efforts

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Many discussions of chemical demilitarisation discuss the long ongoing processes and procedure to deal with historic chemical warfare programmes long since declared to the world community Other discussions involve how we deal with the discovery of abandoned munitions left over from previous conflicts or the Cold War, such as munitions recovered on the Western Front or from the sea. Other parts of the chemical, biological, radiological, and nuclear (CBRN) community often see demilitarisation as technology catching up with history. In effect, chemical demilitarisation is dealing with the past and may not be seen as a new frontier. This may change. The challenge in the future may not be how to deal with old munitions, but newer ones. By this, it is meant that there are possible situations and scenarios where the world may need to address chemical demilitarisation of both munitions and facilities.

This presentation describes hypothetical future demilitarisation scenarios in Egypt, North Korea, and in the former Soviet Union. These fictional scenarios will be set across several periods of time. The presentation will posit possible both general and specific challenges that could face the world community in general and the chemical demilitarisation community in particular. The scenarios will include particular aspects that may pose challenges to existing norms, technical problems, and various intersections between technology, diplomacy, and security. Safety, technical problems, logistical challenges, and political complications will feature in the three scenarios posited in the presentation. The overall objective is to stimulate thoughts and discussions about the future of chemical demilitarisation and how possible technical, operational, and policy-related challenges may be overcome.

Dan Kaszeta is an Associate Fellow at the Royal United Services Institute. He also runs Strongpoint Security, a defence and security consultancy. Dan has 30 years of experience in chemical, biological, radiological, and nuclear (CBRN) defence. He started as an officer in the US Army Chemical Corps and remained in reserve service for years. As a civil servant, he served for six years as CBRN defence advisor in the White House Military Office and then served six years in the US Secret Service Technical Security Division, serving principally in chemical and biological countermeasures. After moving to London in 2008, Mr. Kaszeta worked for 3 years for Smiths Detection before setting up his own consultancy firm in 2011. He is the author of several books and numerous articles. His most recent book is "Toxic: A history of Nerve Agents"; (Hurst, 2020 and Oxford Univ Press, 2021).

CBR Forensic Investigation

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Forensic investigation of CBR incidents is getting more important and not only the crime scene investigation and laboratory work but also the hazardous conditions under which the work has to be done. The recent Covid-19 pandemic made us aware that the traditional forensic methods can not always be applied and additional safety measures have to be taken to protect investigating staff. In the past years criminal acts with fentanyl-derivatives, nerve agents as Novichok took place with that challenging the investigators to use additional safety measures and develop novel investigations methods. In 2014 the EC funded the Framework 7 project GIFT (Generic Integrated Forensic Toolbox for CBRN incidents, 2014-2017) in which research was done to develop forensic methods from crime scene to Court. In the GIFT project work has been done to describe the crime scene process, onsite tools such as: lab-on-a-chip methods to analyse nerve agents, 3D imaging of the crime scene, visualisation of latent fingerprints, isolation and extraction of biological agents, and a γ-camera. Further a vacuum decontamination chamber method prior to traditional forensic investigation has been developed to be applied for DNA analysis, latent fingerprints and digital data on data carriers. For chemical and biological agents the research has been focussed on identification and characterisation of the agents by gas chromatography mass spectrometry for the chemicals and PCR for the biological agents. Enabling to relate the agents to their synthesis route or possible origin a method has been developed by the use of the Bayesian hypothesis model. One of the future developments for CBR forensic investigation is the use of robotica for reconnaissance of the crime scene supporting a more focused sampling strategy at the crime scene.

Eduard van Zalen graduated at the University of Utrecht in analytical chemistry, specialized on environmental methods.

Van Zalen Joined the NFI in 1991, where he subsequently had the positions of Head of Environmental Crimes, Project manager New Facilities NFI and location manager for a collaboration unit between the NFI, the Dutch Police and the Prosecutors Office.

Since May 2008 Van Zalen has been employed as programme manager CBRN within the Netherlands Forensic Institute. The CBRN programme is focused on both the development of CBRN forensic methods as well as international cooperation working on this subject with organizations such as IAEA, INTERPOL, EUROPOL and OPCW. In this position Van Zalen has been in charge of developing the Dutch GIFT Basket for the Nuclear Security Summit 2014, has been Coordinator of the EC funded Framework 7 project GIFT (Generic Integrated Forensic Toolbox) and vice-chair of the Forensic working group of the OPCW Scientific Advisory Board.

The Forensic Science Center at LLNL: Research, Forensics, Training, and Operational Support

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The Forensic Science Center (FSC) at LLNL is a national security asset with a bifurcated mission that includes research and development into the chemical properties and detection methods available across the CBRNE space as well as an operational component that provides sample analysis support to our partners, as well as international training in evidence collection and sample analysis to support counter-WMD efforts. In this presentation, we will provide an overview of the major focus areas of the FSC and provide results of recent efforts in chemical signatures identification, forensic sample analysis, and advanced methods for identification of novel threat materials.

One focus of the FSC has long been efforts towards the forensic analysis of chemical signatures associated with the production of CWA. These signatures may be introduced at many points in agent production and include byproducts, impurities, and unreacted starting materials present or absent in a sample. Our work strives to understand the identity of these signatures, as well as their utility in determining information on the various synthesis pathways available for production. In addition, the phase space of threat materials is ever expanding, and it becomes nearly impossible to maintain a reference library that includes all potential threat agents in all compound classes. Recent efforts have focused on developing methods to address this challenge by focusing analytical methods on class of compounds, rather than individual compounds. In this manner, a novel compound can be flagged for further investigation based on its likeness to a particular chemical class.

In this presentation we will discuss the framework that we use to identify chemical signatures in questioned samples using advanced analytical instrumentation as well as data analysis and mining methods. Our approach to identifying the presence of unknown or novel threat materials based on their compound class will be also discussed.

Audrey Williams is the Director of the Forensic Science Center (FSC) at Lawrence Livermore National Laboratory (LLNL). She graduated from Xavier University (2003) with a B.S. in chemistry and criminal justice, then received her M.S. in Forensic Science (2006) and Ph.D. in Chemistry (2009) from Michigan State University. She began her career at LLNL in 2007, serving in a variety of roles before becoming FSC Director in 2019. The FSC is a national security community asset whose twin missions are to conduct innovative research and provide real-world operational support across a broad range of forensic science. Audrey leads a team of scientists with a variety of technical backgrounds to understand, characterize, and respond to threat events ranging across the full WMD spectrum - including chemical, biological, radiological, nuclear, and explosive scenarios. The FSC is an Organization for the Prohibition of Chemical Weapons Designated Laboratory, providing treaty support capability for the CWC.

The Use of Observables to Determine the Presence or Use of Toxic Chemicals

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Determination of use of and human exposure to chemical weapons is a challenging endeavour. For many of the more volatile chemical agents, detecting and identifying the agent itself in the environment can be very difficult and often only possible in the immediate time period after use. Likewise, the ability to detect and identify a toxic chemical in the body can also pose difficulties given the body's ability to metabolise and otherwise break down these chemicals. Still, the outward effects of such chemicals can often persist for long periods of time.

Given this, opening the forensic aperture to identify other types of observables of chemical weapon use is prudent. One type of observable of increasing interest is that of biomarkers. Biomarkers are biological molecules found in living organisms that provide an indication of normal or abnormal processes, or the presence of a certain condition or disease. They are measurable observables of another process or state that would otherwise be hard to measure or determine. In the context of chemical weapons exposure, biomarkers can indicate the organism's exposure to toxic chemicals and, in many instances, even provide information relating to what the offending toxic chemical was.

This talk will relate some of the Technical Secretariat's experience with observables and will outline its on-going Plant Biomarker Challenge, where scientists from around the world look to enhance the understanding of how vegetation can act as sentinels of the presence or use of toxic chemicals .

Peter Hotchkiss has been working in the WMD/CBRNE space for 12 years. He joined the Organisation for the Prohibition of Chemicals Weapons in 2020 as the Senior Science Policy Officer where he provides scientific advice to the Director-General and the Technical Secretariat and acts as the Secretary to the OPCW Scientific Advisory Board. Prior to joining the OPCW, he spent 11 years at Sandia National Laboratories (SNL), a United States Department of Energy National Lab. While there he initially worked on fundamental research regarding energetic materials' properties and explosives detection modalities. He then decided to pivot his career into countering chemical threats, joining, in 2015, SNL's Global Chemical and Biological Security group. There he worked on implementing cooperative threat reduction initiatives on behalf of the United States Government, assisting countries in preventing the theft and misuse of chemicals.

DIY production of HCN: an insight into Dstl's analytical response

Gail Harrison, Ankit Patel

Dstl

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The UK police and CBRN responder community have substantial experience in the investigation of scenes or crimes involving hazardous materials, but each incident always presents a unique challenge. In 2019 South Wales Police requested Dstl assistance in relation to a property search. The scene was complex and hazardous, with significant numbers of chemicals present – including explosive precursors and literature relating to the production of explosives. A prolific range of chemical warfare related literature was visible, both published and handwritten, alongside chemical apparatus and sketches of a potential delivery system. During interview, the suspect claimed to have made hydrogen cyanide (HCN), and glass vials consistent with this account were found in the suspect's freezer.

The UK National Network of Laboratories conducted analysis of one of the vials and identified the presence of cyanide in a clear liquid with a low boiling point, although identification of the cation was not possible. The Dstl CB Analysis and Attribution Capability was tasked to support the investigation and among other activities replicated the HCN synthesis method the suspect claimed to have used, thereby demonstrating its efficacy. Cyanide residues were recovered from the glassware that was believed to have been used, and relevant by-products were identified in the waste liquids located at the scene, further confirming the production route. The team also developed analytical methods to verify that the vials contained HCN. Despite the challenges of handling HCN, the remaining vials were opened and sampled at Dstl, and the contents were analysed using the developed analytical methods to prove that they contained hydrogen cyanide.

Ankit Patel joined Dstl as an analytical chemist in 2013 and since then has gained extensive experience in instrument analysis of chemical warfare agents, particularly the use of gas chromatography techniques coupled to various detectors. Some of his other areas of interest are developing and validating analytical methods, chemical attribution and chemometrics. Ankit also contributes to the successful performance of internal audits and proficiency tests, allowing the team to maintain its status as UK's Designated Laboratory under the Chemical Weapons Convention. He is a recipient of a team CSA Commendation award and a Member of the Royal Society of Chemistry (MRSC).

Gail Harrison is a Responsible Officer for the National Network of Laboratories, and Technical Manager for CB Forensics at the Defence Science and Technology Laboratory (Dstl). Gail joined Dstl in 2001 as a graduate microbiologist, originally working as a research scientist in a team developing genetic assays to detect dangerous pathogens. During this time she completed a Masters in Medical Molecular Biology, before taking a more operational role in the Chemical and Biological (CB) Analysis and Attribution Capability. Gail has more than ten years' experience as a Responsible Officer, leading teams to triage, screen and analyse samples for the presence of chemical or biological agents on behalf of UK Government.

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Amentum is a new company, created from the legacy company AECOM on 31 January 2020—but a new company with over 116 years of experience in complex project management and over 30 years of experience in the safe and efficient destruction of chemical weapons. Amentum represents the history and experience of the five primary companies that have won contracts to destroy 90% of the US stockpile. Those legacy demil companies were:

- URS
- EG&G
- Washington Group International
- Westinghouse Government Environmental Services
- Raytheon Engineers and Constructors

Amentum previously completed chemical weapons destruction at 5 sites using automated disassembly equipment followed by incineration, safely destroying over 2.5 million chemical munitions which had been stored at Johnston Atoll; Anniston, Alabama; Pine Bluff, Arkansas; Tooele, Utah; and Umatilla, Oregon in the United States. Amentum also safely destroyed six tons of bulk chemical agent in Albania.

Amentum is currently performing ongoing operations at the neutralization-based chemical demilitarization plants in Pueblo, Colorado (PCAPP), and Blue Grass, Kentucky (BGCAPP), which are on target for completion of the U.S. Chemical Agent Stockpile no later than 31 December 2023 despite the ongoing pandemic.

PCAPP has exceeding 7 million man hours worked (August 2021) without a lost-time incident. The project successfully completed their 155mm projectile campaign in September 2021 and are 54% complete on their 105mm projectile campaign. The project is poised to commence operations on their three Static Detonation Chambers (SDCs) October 2021 to address problematic chemical weapons that can be safely and efficiently processed using this technology. Overall the team has destroyed over a half-million chemical weapons (September 27, 2021) and has achieved the all-time chemical demilitarization records for single day, weekly and monthly destruction.

BGCAPP has completed destruction of 8-in GB projectiles and 155 VX projectiles. The GB campaign marked the completion milestone of the destruction of all GB projectiles in the US stockpile. SDC technology was utilized at BGCAPP to complete destruction of their problematic 155mm H projectiles in September 2021. BGCAPP is currently draining and overpacking VX rockets for future disposition in the SDC-1200 pending upgrades. Construction and systemization of the SDC-2000 facility are in progress to facilitate the destruction of overpacked GB M-55 rockets and drained GB rockets warheads.

Of particular interest to the international community is that at Pueblo and Bluegrass, Amentum is pioneering the use of Static Detonation Chambers, a Dynasafe system, for safe and effective destruction of chemical agents. Six SDCs will be deployed to facilitate the destruction mission for these last two sites. The use of this technology demonstrates the breadth of experience of Amentum. We have deployed liquid incineration systems (direct injection), metal parts furnaces (roller hearth), deactivation furnaces (rotary kiln) at five sites. We have deployed a bespoke system (The Eisenmann Thermal Treatment System) in Albania to evaporate and burn the bulk liquid agents present at this site, and are now operating bulk neutralization techniques, metal parts treaters and static detonation chambers at Pueblo and Bluegrass. This variation in technical approach is only matched by our flexibility in meeting the unique challenges of each chemical weapons destruction program. Some of the major safety highlights from sites include:

- Four sites achieved 10 million consecutive work hours without a lost time incident
- Our employees excelled in safety, averaging no more than one Occupational Safety and Health Administration (OSHA)-recordable injury for every 200,000 worked-hours which is better than the typical U.S. office environments
- All sites were recognized by OSHA as Star Status facilities during operations under the Voluntary Protection Program
- Four plants were ISO 14001-registered—an industry standard that provides requirements for environmental management systems

MUNITION SEA DUMP CLEARANCE AND DISPOSAL

This generation has inherited the remnants of previous UXO disposal techniques, including sea dumping. Millions of tons of discarded obsolete conventional munitions and chemical munitions lie scattered across the ocean floor. The world has hundreds of these sea dumpsites worldwide. Some are in shallow waters, where chemical warfare agents are leaching into the water and seabed and will eventually create an environmental hazard and impact on sea life as well as close shore issues.

Existing procedures result in the recovered ordnance being brought to shore or being disposed of at sea. Both of these options have associated high safety and environmental risks that could be eliminated by operating completely offshore with Dynasafe, without the requirement to bring dangerous and unstable munitions to shore, while disposing of the munitions in a clean and environmentally safe manner.

Dynasafe is confronting this new challenge and is developing our offshore disposal toolbox. Our key disposal tool is proven Static Detonation Chamber (SDC) technology which will do the final disposal. To support this will be a toolbox of support technologies to ensure the larger items of ordnance are safely broken down into smaller parcels. Dynasafe's approach is cost-effective and keeps the environment and our communities safe. We are happy to work with any government or company to set up an all-in-one offshore disposal facility.

Dynasafe supports the offshore demilitarisation mission by:

- Providing engineering design support for your specific demilitarisation mission.
- Building, fabricating, or customizing the demilitarisation hardware or plant to dispose of conventional or chemical weapons.

Dynasafe can also provide operations support for the demilitarisation mission, by providing staff to manage, operate, or service your demilitarisation facility. Services offered are:

- Operational Concept Design
- Project Management and Operational Management
- Destruction Plant Operators
- Ordnance Demilitarisation Specialists
- Process Engineering Specialists
- Chemical and Analytical Expertise
- Explosive Storage and Handling Specialists
- Maintenance and Engineering Support
- Specialist Training

Whether you are starting your demilitarisation mission, are already disposing of munitions, or are simply interested in best practices to help your team improve efficiency or safety, Dynasafe's engineering team has the knowledge and experience to get you headed in the right direction.

Please feel free to contact Burt Kearney at +49 (0) 172 5836956 or at burt.kearney@dynasafe.com for additional information or questions.

KOBE Steel, LTD. is the only company which develops, designs, manufactures and operates detonation systems for Chemical Weapons Destruction. The system is named Davinch®.

There are total four systems under operation and / or installed over the world, in Belgium, France, China. Over 60,000 chemical warfare materials have been safely destroyed by using Davinch®. Other destruction projects are already planned in north part of China. These activities are based on Kobe's technical legacy of development of armor materials for defense, fabrication of ultra-high and huge pressure vessels and wide spectrum of engineering experience in plant processes and operations including the nuclear industries.

- **Poelkapelle Project in Belgium**: The site is located in the middle of Flanders field, a major site of early chemical warfare materials from Word War I. Kobe Steel provide supervisors for yearly maintenance of DVAINCH. Over 10,000 munitions have been destroyed including hazardous munitions of 21cm Clark shells, Livens, and shells filled with Phosgene, Chloropicrin etc.

- **SECOIA Project in France:** The site is located in the northeast part of France, which mainly destroy World War I chemical warfare materials. SECOIA is the name of project scheduled to last more than 20 years.

- **ACW destruction projects in China:** Kobe Steel has been undertaking the destruction service of Abandoned Chemical Weapons (ACWs) using mobile Davinch® system in Nanjing since 2010 and subsequently at other sites in southern part of China . Also, two other ACWs destruction projects, one in northern part by mobile type Davinch® and the other in Haerbaling by fixed type Davinch® which is under operation. Another large fixed type DAVINCH® are planed in Haerbaling.

- **Port Kanda Project in Japan:** Port Kanda is located in the heavily industrialized area. During dredging of the port, chemical weapons were found. Kobe Steel supplies services to survey, recover, transport and destroy chemical weapons from the sea. Davinch® is used to destroy all of the munitions from Port Kanda. Approximately 3,000 items of 50kg yellow bombs with mixture of Mustard +Lewisite and 15kg red bombs with Diphenyl-chloroarsine or Diphenyl-cyanoarsine have been destroyed.

- **Samukawa Project:** Kobe Steel destroyed chemical agent in over 800 beer bottles recovered from the highway construction site near Yokohama. The destruction site was in a municipal area and near a heavy traffic load. An additional 8,000 cubic meters of soil was decontaminated by rotary kiln.

DAVINCH of Poelkapelle

Technologies for Chemical Weapon Destruction: With complete project experience and capabilities in CWD projects, Kobe Steel Group offers broad capabilities for safely treating and destroying chemical weapons. Major technologies and products include:

- Chemical neutralization processes
- Controlled detonation process (Davinch®)
- Air pollution control systems
- Robotic handling of hazardous Materials
- Plasma process for non-combustible waste
- Incineration processes
- Special waste form evaluation
- Transportation chamber
- High efficiency magnetometer system for detection and identification of old metallic munitions
- DESTINY life cycle Management

ANSER supports DoD initiatives across the CWD mission spectrum. The team leverages a broad network that includes business service executives, former senior executives and flag officers, and experts in chemistry, engineering, acquisition, policy, and contracting to identify comprehensive and practical solutions for our customers.

Deputy Assistant Secretary of Defense (Threat Reduction and Arms Control) (DASD(TRAC))
For over 25 years, ANSER has supported the DASD(TRAC), who provides guidance and direction for the implementation of the Cooperative Threat Reduction and U.S. Chemical Weapons Demilitarization Programs, as well as DoD compliance with arms control agreements and sponsorship of solutions for countering WMD. In addition to defining and monitoring cost, schedule, and performance parameters, the ANSER team evaluates progress, identifies challenges, and recommends appropriate interventions to ensure mission success. Our team's extensive subject matter, program management, resource allocation, and policy expertise aids DASD(TRAC) in preparing strategic plans and guidance, evaluating budgets, and engaging stakeholders. ANSER supported the DoD's role in negotiating and planning for the destruction of Syria's declared chemical weapons and continues to assist in achieving operational flexibility for future chemical weapons destruction operations, evaluating domestic and international adherence to the Chemical Weapons Convention, and providing sound recommendations for the Program Executive Officer for the Assembled Chemical Weapons Alternatives Program (PEO ACWA).

PEO ACWA The ANSER team is instrumental in helping the PEO ACWA develop insightful analyses and comprehensive strategic plans to ensure mission completion at both of its chemical weapons destruction sites. The ANSER workforce is integral, not only to daily operations, but to the strategic direction, acquisition planning, and success of the mission to safely destroy the nations' roughly one million remaining chemical weapons by December 31, 2023.

About the Organisers

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The Defence Science and Technology Laboratory (Dstl) is an Executive Agency of the UK Ministry of Defence (MOD) and the science inside UK national security. We work to deliver high impact science and technology (S&T) for the benefit of the UK's defence, security and prosperity.

Dstl focuses on providing S&T solutions to the complex challenges that defence and security face, both today and in the future. We maintain unique capabilities to combat existing and emerging threats from adversaries (state, terrorist or criminal) wherever they appear. Through the S&T that we steward and deliver, our knowledge and experience spans from sea to space, embracing both the physical and technological, and increasingly in the areas of cyber security and artificial intelligence. Dstl is responsible for delivering the MOD S&T research programme which, combined with other defence research programmes, accounted for nearly 90% of Dstl's total sales budget of £703 million in 2020. Around 40% of the total S&T research programme was delivered through our industry partners and academia. We engage collaboratively with many suppliers, academic institutions and peers, nationally and internationally, to deliver world-class solutions to the most challenging issues in defence and security.

Dstl hosts the UK's only laboratory designated by the Organisation for the Prohibition of Chemical Weapons (OPCW) for analysis of authentic chemical samples. The UK's Designated Laboratory is part of a global network of laboratories, which plays a critical role in the Organisation's verification regime and its capacity to investigate allegations of the use of chemical weapons. Specialists from Dstl have supported the work of the Chemical Weapons Convention for many years, including providing technical advice to the UK negotiators.

Dstl has a long history of international collaboration, regularly training overseas operators in munitions disposal, as well as offering advice to other nations on best practice. These services help to prepare people to work safely in toxic and hazardous environments. Specialist teams are also available to provide support in addressing contaminated land, which is an important environmental and political legacy issue for MOD.

[dstl] The Science Inside

Find out more

Visit: www.gov.uk/dstl / Follow us on Twitter @dstlmod

U.S. Army National Guard photo by Sgt. Harley Jelis

Getting in Touch

We are always looking at ways to ensure the CWD Conference remains a valuable event for sharing information and lessons learned, and for making professional contacts. If you would like to share your ideas, suggestions or feedback, please contact us at CWDConference@dstl.gov.uk.