Science & Technology

CSAC™

Chemical Security Analysis Center

FISCAL YEAR

2022

ANNUAL REPORT

APPROVED FOR PUBLIC RELEASE

CONTENT

CSAC™
Chemical Security Analysis Center

The Department of Homeland Security (DHS) Science and Technology Directorate (S&T) Chemical Security Analysis Center (CSAC) is the Nation's only federal studies, analysis, and knowledge management center for assessing the threat and hazard associated with an accidental or intentional large-scale chemical event or chemical terrorism event in the United States.

CSAC's mission is to assess and address chemical threats to the homeland.

CSAC accomplishes its mission by:

- Collecting, consolidating, curating, storing, and sharing chemical data
- Generating science-based assessments and recommendations and identifying emerging trends based on vetted data
- Identifying, prioritizing, and addressing data gaps through high quality chemical research, development, test, and evaluation

CSAC serves the Homeland Security Enterprise and its stakeholders by staffing and operating a 24/7 Technical Assistance program that provides operational support and subject matter expertise, designing and executing laboratory and field tests and providing a comprehensive knowledge repository of chemical threat information that is synthesized and updated with data from scientific, operational, and private-sector sources.

1 CSAC & DEVCOM CBC Partner to Provide New Chemical Security Laboratory Capability

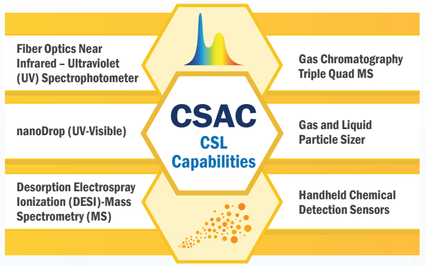
> *CSAC's Chemical Security Laboratory will be a vital organic capability for S&T. Having the ability to conduct our own experimental laboratory research alongside our Army partners brings a more holistic approach to our chemical security analytics and allows us to model analyses rapidly in support of DHS components and other federal, state, and local partners with greater precision.*
>
> *– Kathryn Coulter Mitchell, DHS Senior Official Performing Duties of the Under Secretary for Science and Technology*

In partnership with the U.S. Army Combat Capabilities Development Command Chemical Biological Center (DEVCOM CBC), CSAC opened a new experimental Chemical Security Laboratory (CSL). This new capability will enable CSAC's team of DHS and Army experts to fill critical data gaps essential to national readiness.

CSAC received the Under Secretary's Award for Building Partnerships for the establishment of the CSL. This new laboratory capability synergistically positions CSAC to address the increasing number of chemical threats requiring specific experimental characterization.

The new laboratory will benefit CSAC's risk and consequence models and contribute essential data to current S&T projects, such as chemical hazard characterization and gas forming reactions.

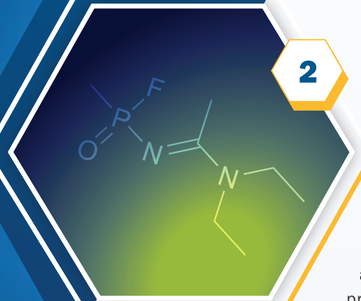
> *We are proud to continue our many years of productive collaboration with DHS S&T and now extend this partnership with hands-on work in the shared laboratory space. CSAC brings together DHS and Army experts in chemical hazard detection, characterization, and analysis. This collaborative laboratory enables them to work together in a new capability set, taking full advantage of the physical co-location of CSAC with CBC, as intended at its founding.*
>
> *– Dr. Frederick Cox, DEVCOM CBC Director for Research and Technology*



Locating CSAC's CSL at Aberdeen Proving Ground – a Department of Defense installation – improves the laboratory's capability and return on investment. The CSAC CSL provides unique and vital capabilities not found at any of CSAC's sister laboratories under the DHS S&T Office of National Laboratories. CSAC makes efficient use of the strong partnership with DEVCOM CBC to employ critical capabilities such as volatile organic compound monitoring, gas sensor array technology (e.g., electronic-nose), and imaging mass spectrometry.

Wasting no time leveraging its new capability, CSAC developed in-house protocols for determination of Solubility and Octanol-Water Partition Coefficient, the results of which will feed into the next round of data collection for the DHS S&T strategic program Probabilistic Analysis for National Threats Hazards and Risks (PANTHR). CSAC's CSL was also utilized for work involving chemical electronic-nose detection of chemical threats in an aerosol state as well as proof of concept and determination of the limits of detection in support of CSAC's Rapid Cyanide Detection program.

Fourth Generation Agents - Science Assessments Prepared for DHS CWMD



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Fourth Generation Agents (FGAs) are a significant toxic chemical concern and pose unique challenges for chemical defense and response. CSAC subject matter experts (SME) are at the forefront of research, producing four key science assessments examining and evaluating test data in the areas of Physical Properties, Detection, Personal Protective Equipment, and Decontamination for these agents. The assessments were important contributions to the first ever multi-agency and international FGA Workshop sponsored by the Department of Homeland Security Countering Weapons of Mass Destruction Office (DHS CWMD).

CSAC's assessments were key to informing workshop participants and accomplishing the goals of the workshop – determining what is currently known and what information is still needed – to assess whether the U.S. is prepared to prevent and respond to the FGA threat. In addition, CSAC conducted modeling of DHS CWMD priority scenarios which served as the basis for the analysis during the workshop breakout sessions.

CSAC's contributions represent a significant step toward combating FGA threats. The outcome and follow-on work will have lasting benefits for the chemical defense community, informing the development of a whole-of-government common understanding of the threat and the state of the science, analysis of the current readiness level and proposed solutions, and identification of needed critical research, development, testing, and evaluation efforts. CSAC's participation before, during, and after the workshop is essential toward successful outcomes for the chemical defense community.

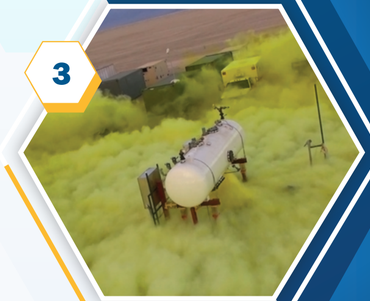
FGA Science Assessments for:

- Personal Protective Equipment
- Decontamination
- Physical Properties
- Detection

> *I want to personally thank your team ... for their modeling and simulation support which played an essential role in framing the consequence and effects of these science-based scenarios. Based on the scenarios, participants proposed solutions that will significantly enhance preparedness and identified critical research and development needs to help further our understanding of this threat…*
>
> *– DHS CWMD Office*

CSAC Experts Support Emergency Planning Through Tabletop Exercises

3



A toxic chlorine gas release captured during the 2016 Jack Rabbit II field trials

Emergency Preparedness

Staff from CSAC advised the S&T Vermont Avenue Command Center Team (CCT) throughout the planning, execution, and evaluation phases of a tabletop exercise (TTX) designed to test participants' knowledge of emergency preparedness policies and procedures. The exercise included a hypothetical scenario involving a toxic chlorine gas release. CSAC provided a modeling assessment, as well as video footage, of a toxic gas release captured during the 2016 Jack Rabbit II field trials, which the CCT presented during the TTX. During the exercise, the CCT contacted CSAC's 24/7 Technical Assistance for support. CSAC also contributed to the after-action report where the CCT noted CSAC's importance as an in-house, on-call resource for chemical threat scenarios.

Emergency Response

CSAC participated in a virtual intergovernmental TTX designed to familiarize participants with their respective roles in a response to a hypothetical fentanyl contamination of a beverage sold at a state fair. The Indiana State Police and the Indiana Department of Health co-led the exercise, which was hosted by the FBI Weapons of Mass Destruction Directorate. The hypothetical scenario used during the TTX involved symptomatic people arriving at a hospital, and the discussions focused on response actions and communications between the participating agencies and the hospital. As this TTX scenario has been included in PANTHR risk modeling, CSAC was able to provide insight into this scenario as well as identify areas for improvement in the risk models.

Security Planning

CSAC participated in the Multi-Jurisdictional Improvised Explosive Device Security Planning Workshop held by the Office for Bombing Prevention (OBP) in Las Vegas, Nevada. CSAC analyzed the scenario using the Homeland Explosive Consequence and Threat (HExCAT) software tool, developed in-house by CSAC experts. Participants were impressed with HExCAT's ability to simulate the number, severity, and type of injuries. CSAC's participation in the TTX provided awareness of the enhancements that the HExCAT model could provide to the various types of exercises and workshops that OBP conducts, including reducing pre-exercise modeling time while providing a far greater capability to include an expanded scenario class and integrated medical mitigation modeling.

Image credit: FBI

4

CSAC Plays Key Role in NSTC-JEEP Initiatives

Per- and Polyfluoroalkyl Substances (PFAS)

CSAC provided SMEs to the White House Office of Science and Technology Policy's National Science and Technology Council (NSTC) Joint Subcommittee on Environment, Innovation, and Public Health (JEEP) PFAS strategy team. The team completed a Research and Development Report and developed a strategy for replacing PFAS chemicals, which are employed on a large scale in firefighting foams around the world. Movement away from these chemicals would have a positive impact on the environment and the health of first responders. The SMEs provided expertise to determine the impact on public health and the environment, determine methods to mitigate those impacts, and identify how PFAS may be reduced in use and replaced with other highly functional chemicals.

Sustainable Chemistry

CSAC provided SMEs to support the NSTC-JEEP to address several congressional mandates including defining sustainable chemistry, performing landscape analysis on Federal sustainable chemistry activities, developing a Federal strategic plan to characterize and assess sustainable chemistry, and coordinating Federal efforts in the areas of regulation, research and development, and challenges. CSAC prepared a public request for information, required by Congress to obtain community input on considering expanded sustainable chemistry concepts to include supply chain, jobs, and national security.

The unique expertise at CSAC is a force multiplier for the U.S. and is being used to establish science-based priorities and policies that enable a shift towards sustainability.

Drinking Water Contaminants of Emerging Concern

CSAC provided food defense SMEs to support the NSTC-JEEP Drinking Water Contaminants of Emerging Concern strategy team to help address and protect the U.S. water supply. CSAC contributed to the development of a coordination matrix to tabulate areas of interest, including non-targeted analysis, effects-based monitoring, development of analytical methods, better approaches to understanding mixtures, leveraging artificial intelligence, and generating meaningful lists of contaminants. NSTC-JEEP published and transmitted to Congress the "Update to the Plan for Addressing Critical Research Gaps Related to Emerging Contaminants in Drinking Water."

Food Adulteration Modeling Guides Impactful Defense

5

CSAC is at the forefront of modeling food adulteration scenarios which aid the food sector in focusing food defense planning, preparedness, and mitigation efforts to secure our food supply and save lives. An integral partner in the food defense arena, CSAC's work has been recognized across DHS and highlighted in the Homeland Security Special Edition of USA Today.

The U.S. food supply has significant risk exposures related to public health, plant, and animal safety. The routine use and availability of many highly toxic chemicals provide ample opportunity for food adulteration. In FY 2022, CSAC supported the DHS CWMD Food, Agriculture, and Veterinary Defense Division during collaborations with stakeholders to identify and mitigate threats to the U.S. food supply.

Food and Food Process Characterization

CSAC partnered with the Food Protection and Defense Institute to perform a cluster analysis using a binary scoring system of food and food process characteristics to identify a set of clusters representative of the food supply chain. An exemplar food from each cluster was then selected by SMEs from the food industry and academia as a representative scenario for that portion of the food industry. Ongoing data collection is focused on potential adulterants, contamination points, preparation methods, consumption profiles, and recall for these clusters.

Chemical Organoleptic Characterization

As part of the Solubility, Toxicity and Organoleptic Profile of Toxic Chemicals of Interest (STOP-TIC) program, CSAC partnered with U.S. Army Medical Research Institute of Chemical Defense to determine solubility, and acceptability/palatability in water, milk, and apple juice for ten chemicals. These data from STOP-TIC are critical for the accurate assessment of food risk.

Industry Collaborations

CSAC SMEs underscored the national security implications of safe and available food during the 2022 International Association for Food Protection Conference. In collaboration with DHS CWMD, the S&T Office of Mission and Capability Support, and Customs and Border Protection, CSAC spearheaded discussions with nearly 100 attendees focused on developments and efforts occurring in food defense and risk mitigation. At multiple Food Defense Consortium meetings, the food defense industry's premier event for networking and educational opportunities, CSAC participated in and led discussions on trends related to food defense, supply chain, and safe water supply.

6 Worldwide Expansion of Partnerships Through Interagency Connections

CSAC INTERAGENCY CONNECTIONS

- Irregular Warfare Technical Support Directorate
- National Counter Terrorism Center
- Transportation Security Administration
- Department of Health and Human Services
- Countering Weapons of Mass Destruction Office
- U.S. Department of Defense
- U.S. Army Nuclear and Countering Weapons of Mass Destruction Agency

AIRCRAFT MODELING HARMONIZED IN JOINT COLLABORATION

CSAC and the UK Centre for the Protection on National Infrastructure, Defense Science and Technology Lab, and the Department for Transport (Dft), along with the Transportation Security Administration (TSA) and the U.S. Department of Defense Irregular Warfare Technical Support Directorate (IWTSD) continued longstanding collaboration toward understanding chemical and biological releases on aircraft and potential mitigation options. CSAC and the UK developed and refined common modeling platforms for multiple airframes and co-authored a validation test report for an airframe based on tracer trial releases completed in January 2020.

A common workplan was developed to explore the impact of short-term options such as changes in the aircraft operation as well as longer term options such as enhanced filtration or sorbent beds. The U.S. and UK are revising the approach, assumptions, and key parameters needed to provide harmonized scientific advice to TSA and DfT. This joint approach will save resources and provide clear, consistent recommendations to enable efficient development of screening detection standards.

CHEMICAL CHARACTERIZATION & FORENSICS EMPHASIZED IN BILATERAL ENGAGEMENT

CSAC participated in a bilateral meeting in Stockholm, Sweden with Swedish Civil Contingencies Agency and Swedish Defence Research Agency to identify continuing and new areas for collaboration, which include chemical forensics, large scale release characterization, the development of evidence based human toxicity estimates, and identification of biomarkers indicative of chemical exposure.

A follow-on meeting recapped 15 years of collaboration and looked forward to continued engagement in the areas of explosives and chemical characterization. The U.S. and Sweden emphasized the importance of chemical characterization of emergent threats well before they are used to ensure that a timely response and guidance can be based on solid evidence.

CHEMICAL CONTAMINANT FLOW CHARACTERIZED IN TRANSPORTATION STATION FIELD TRIALS

CSAC participated in a joint U.S.-Israel field trial in the newly constructed subway station in Tel Aviv, Israel. The trials characterized the airflow in the station and evaluated the impact of various mitigation measures such as opening and closing doors to the station; turning the heating, ventilation, and air conditioning system on and off; activating the fire and smoke fans; and over-pressurizing evacuation stairwells in the event of a chemical release. The ability to characterize a newly constructed subway system and compare the results to an older U.S. subway system will allow identification of critical parameters that will influence contaminant transport and inform the transportation station's emergency response doctrine.

FGA HAZARD MANAGEMENT DISCUSSED AT NATO MEETING

The CSAC contamination survivability SME was invited by the U.S. Army Nuclear and Countering Weapons of Mass Destruction Agency (USANCA) to join the U.S. Delegation as the chemical expert and participate in the North Atlantic Treaty Organization (NATO) Hazard Management Panel (HMP) Spring 2022 meeting in Spiez, Switzerland. At the meeting, CSAC presented on FGAs and led a discussion on Pharmaceutical-Based Agents – a category of chemical threat agents that includes synthetic opioids. In partnership with USANCA, which provides radiological and nuclear expertise to the U.S. Delegation, CSAC is working with the UK delegation to revise NATO Allied Engineering Publication 58, "Combined Operational Characteristics, Technical Specifications, Test Procedures and Evaluation Criteria for Chemical, Biological, Radiological, and Nuclear Decontamination Equipment." CSAC will continue to participate as the chemical expert on the U.S. Delegation to the NATO HMP.

AVIATION SECURITY RESEARCH SHARED BETWEEN DEFENSE ORGANIZATIONS

CSAC SME traveled to Australia to discuss chemical and biological defense issues with Australia's Defense Science Technology Group (DSTG). The U.S. delegation shared with DSTG their ongoing research in aviation security and other areas. DSTG briefed the U.S. on its aviation modeling research, toxic chemical mitigation, toxicology, and other areas of mutual interest.

7

Jack Rabbit Program Forges Path

CSAC successfully executed small-scale outdoor ammonia release (SOAR) field experiments at the Technology Experimentation & Characterization Field Trials (TECFT) at Dugway Proving Ground. The TECFT functions as a gateway for assessing technical innovations ready for transition into commercially available technology. CSAC demonstrated the utility of the Federal Emergency Management Agency's ChemResponder as a real-time common platform that first responders can use to aggregate and display critical data feeds during chemical incidents. Geospatial, meteorological, and chemical sensor data were successfully collected during the testing and shared live on the ChemResponder platform, along with dynamic hazard plume modeling output.

The success of the SOAR tests paves the way for the Jack Rabbit III team to deploy ChemResponder in potential future larger-scale ammonia release experiments, in which integrated sensor and data feeds could be shared in real-time with a network of partners.

Nationwide Toxic Industrial Chemical Hazard Interactive Mapping Tool

To better understand and assess the potential for a toxic industrial chemical release from a terrorist attack on the Chemical Supply Chain, CSAC developed a nationwide toxic industrial chemical hazard map. This interactive map is built on the Homeland Security Information Network Geospatial Information Infrastructure portal and includes data relating to the most widely produced, distributed, and used chemicals in the U.S. Included in the tool is an integrated risk scoring methodology which accounts for population factors that may be most affected by a release.

> *"A sincere thank you from HSE for your leadership and expertise in running the Jack Rabbit II chlorine trials – the JRII videos had a deciding impact in the planning inquiry...which evaluated a proposed housing development near the UK's main chlorine production facility. It's a good example of robust scientific work providing a clear positive outcome for public safety. We really appreciate your help."*
>
> *– Health and Safety Executive Science and Research Centre, United Kingdom*

This map can be a resource for first responders and other emergency responders for outreach, enabling DHS to focus security concerns on the most impacted regions of the country. CSAC will transfer this technology to DHS Cybersecurity and Infrastructure Security Agency, Countering Weapons of Mass Destruction, and the Federal Emergency Management Agency to help inform decision makers that manage risks.

SMEs Engage with Department of Energy Labs

8

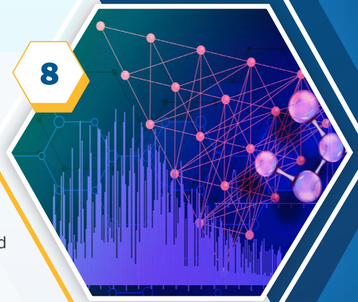


Image credit: PNNL

M/Q Review Board

CSAC was invited to participate in the Review Board for the Pacific Northwest National Laboratory (PNNL) m/q Initiative, a program intended to fund projects which can dramatically alter basic approaches to challenging scientific problems. The m/q Initiative includes projects using different computational approaches, at times coupled with machine learning techniques, to tackle the challenging problem of predicting spectra and signatures from chemical structures and predicting structures from signatures without the constraints of a reference library of known materials. These high risk, but very high reward, projects would move the Homeland Security Enterprise closer to agent-agnostic detection, a key goal in the landscape of rapidly emerging threats. CSAC is working with PNNL to further explore how these advances can impact the effectiveness of screening approaches needed to protect the Homeland.

Emergency Management Issues Special Interest Group

CSAC was invited by the Department of Energy's (DOE) Emergency Management Issues Special Interest Group (EMI SIG) to present an overview at the Subcommittee on Technical Analysis and Response Support (STARS) virtual meeting highlighting technical assistance, data informatics, large scale chemical release studies, chemical hazard characterization, and chemical risk capabilities. The briefing initiated a dialogue with the STARS group and highlighted chemical defense mission areas for future discussion and potential collaboration.

As a result of the STARS virtual meeting, CSAC was invited to EMI SIG's annual meeting, at which CSAC provided a deeper dive on the Chemical Agents Reactions Database and chemical hazard characterization, as well as Jack Rabbit III emergency planning, response, and management. CSAC's participation provided an opportunity to establish connections within the emergency response community of the DOE national labs. CSAC has been invited to join the STARS and encouraged to continue to participate in EMI SIG's annual meetings.

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