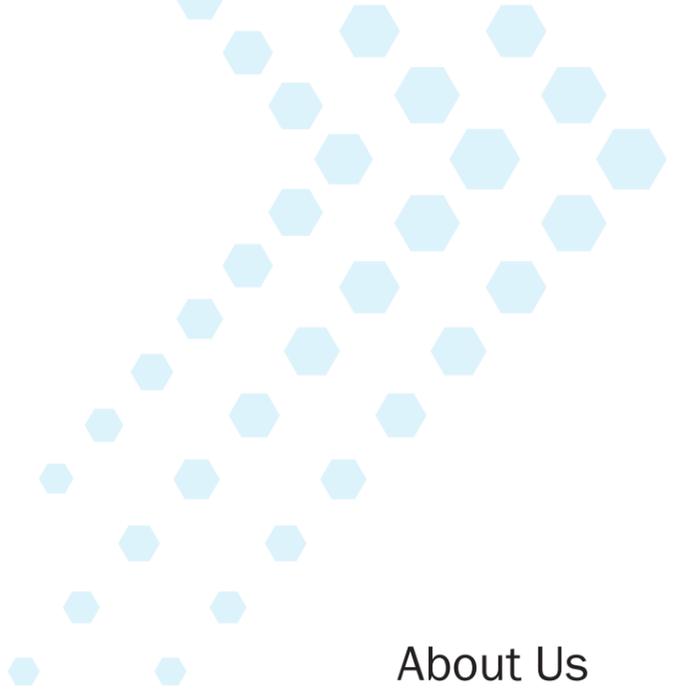


FISCAL YEAR
2021
ANNUAL REPORT



Science &
Technology





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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

As COVID-19 continued to sweep around the globe, CSAC's commitment to its mission remained strong. CSAC, and its staff, strengthened partnerships, implemented and expanded tools and techniques, and made scientific advancements critical to assessing and addressing chemical threats.

1

Chemical Dispersion Modeling Prepared for Events in U.S. Cities



Credit: Tom Hilton



Credit: Carol M. Highsmith

Responding to a new demand signal, CSAC led a matrixed team with the Probabilistic Analysis for National Threats Hazards and Risks (PANTHR) program and the Hazard Awareness and Characterization Technology Center (HAC-TC) to develop and analyze potential indoor and outdoor chemical and biological release scenarios to support special event planning for U.S. cities.

Tailored chemical hazard assessments were provided to Las Vegas and Los Angeles authorities for their New Year's Eve celebrations. CSAC crafted risk-based scenarios to understand the impact of, and lessen the risks associated with, an accidental or intentional chemical release. Using high fidelity atmospheric dispersion modeling, event-specific population density data, and local meteorology, CSAC evaluated the release, response capabilities, and potential security mitigation measures.

In response to a request by San Francisco, through the Cybersecurity & Infrastructure Security Agency's (CISA) Protective Security Advisor (PSA) Program, CSAC and HAC-TC conducted a comprehensive modeling analysis of the chemical and biological impacts of releases for the 2021 Pride Parade and related events. CSAC scoped indoor and outdoor scenarios with San Francisco city officials and using risk assessments from PANTHR, performed modeling using the Countermeasure Assessment and Planning Tool (CAPT) WEB as well as the Defense Threat Reduction

Agency's (DTRA) Hazard Prediction Assessment Capability (HPAC) tool. A detailed analysis of indoor scenarios and festival events along the parade route was developed. In a joint briefing, CSAC staff presented the impactful results to CISA, PSA, the Federal Bureau of Investigation (FBI), and San Francisco Police and Emergency Services. Select chemical release scenarios provided the basis for a joint federal, state, and local emergency response exercise.

CSAC was awarded the DHS 2021 Under Secretary's Science and Engineering Award for chemical and biological dispersion modeling supporting preparedness and response planning activities.

“On behalf of the San Francisco July 4th Federal Coordination Team, I would like to say thank you very much for the outstanding work effort...[CSAC staff] contributed to realistic scenario development which was absolutely critical for providing a professional and believable tabletop exercise scenario...”

– DHS Homeland Security Investigations



Credit: MSG Joy Dulen

2

CARD Advances Chemical Forensics Studies

In Fiscal Year (FY) 2021, improvements to the CSAC Chemical Agents Reactions Database (CARD) resulted in a reinvigorated Chemical Forensics program. The CARD incorporated several significant upgrades and features including system architecture improvements and massive data inflows. Improvements to the architecture included a more logical navigation panel and improved search capabilities making the recovery and aggregation of information more efficient and accessible to users. New data filled knowledge gaps related to 60 high interest threat chemicals, including 68 new synthetic pathways. Together, these advancements greatly enhance the user experience and utility of the CARD.

After several years, the area of Chemical Forensics regained importance, specifically in the areas of Chemical Warfare Agents and Illicit Drugs. CSAC expanded long held relationships with stakeholders within DHS such as the Countering Weapons of Mass Destruction (CWMD) Office and Transportation Security Administration, and across the interagency to include the

Department of State and FBI. Additionally, CSAC focused engagement in working groups such as the Chemical Forensics Coordination Working Group and the Chemical Forensics International Technical Working Group. In these ongoing engagements, CSAC represents and speaks for the whole of DHS S&T as the subject matter expert (SME) regarding the science related to chemical forensics. The refocus in this area is one of the driving forces behind the establishment of CSAC's Chemical Security Laboratory which will provide an expanded forensic studies capability in support of U.S. and international interdiction efforts.

DHS S&T CSAC Wins ASTORS Award in FY 2021 for Excellence in Homeland Security for CARD



“You are truly scientific experts and present with professionalism and clarity.”

– Federal Bureau of Investigation



Credit: GAO

	5	Interagency Modeling and Atmospheric Assessment Center standby requests .
	14	major topics regarding facilities and chemicals surrounding an area.
	16	agencies contacted CSAC .
	27	RFIs addressed in FY2021.

3

Responded to Multiple Chemical RFIs

Multiple requests for information (RFIs) related to chemical threats and chemical hazards were addressed through CSAC's 24/7 Technical Assistance capability, which is a key resource for federal, state, local, territorial, and first responder agencies.

Chemical Supply Chain

CSAC supported CISA's efforts to monitor and understand the commercial supply chain for chemicals in COVID-19 testing kits, additives to vaccines, and disinfectants. As demand for these critical items increased, the availability dropped dramatically. CSAC monitored a selection of critical chemicals and developed a list of domestic manufacturers and their capabilities. At CISA's request, CSAC focused on citric acid, a critical component of a major U.S. vaccine, to monitor domestic and potential non-traditional sources and report on known manufacturers and distributors. Citric acid is employed to balance pH of the vaccine for greater tolerance by the patient. As the pandemic progressed, CSAC noted increased lead times for delivery of citric acid and other critical chemicals and alerted CISA to the need for monitoring domestic chemical supply chain resiliency.

Illicit Drugs

CSAC informed the intelligence community regarding prioritizing commercially available chemicals as important precursors in the illicit drug industry. Illicit drugs were a topic of interest for a Defense Intelligence Agency (DIA) request in which phenylacetone was identified as a link between the production of methamphetamine and fentanyl analogs. CSAC also assisted the DIA in prioritizing unregulated commercial chemicals which can easily be converted to an illicit drug precursor. As a result of this work, CSAC was selected to represent DHS S&T in the Illicit Drugs Detection and Fentanyl Intelligence Community Working Groups.

"[You've] become our go-to on all things chemistry... Thanks for the lightning fast response..."
 – Defense Intelligence Agency

Risk Management Planning

The Federal Protective Service and DTRA requested information regarding potential chemical threats to the Environmental Protection Agency's Risk Management Planning regulated facilities. CSAC provided information about potential risk-based scenarios containing hazardous chemicals of interest. The information provided by CSAC enabled these agencies to complete Threat Assessment Reports and Chemical Risk Analyses.

4

Assessed Emergent Incidents for Safe Drinking Water and Environmental Contamination

CSAC aligns its capabilities and expertise to rapidly respond to chemical related situations as they arise. Leveraging its 24/7 Technical Assistance capability, CSAC quickly assesses the response requirements of stakeholder requests and prioritizes resources for events needing rapid response. In two notable instances, CSAC's response was in the form of a Quick Reaction Bulletin, providing DHS leadership and the interagency critical information and analysis.

Florida Water Treatment Plant Incident – Oldsmar FL

CSAC developed a tailored chemical assessment regarding the incident at the Oldsmar, Florida Water Treatment Plant on February 5, 2021, for the Senior Official Performing the Duties of the Under Secretary of S&T and the Secretary of DHS. The assessment provided chemical information specific to Oldsmar, as well as other historical incidents, including potential public health impacts and water treatment chemicals of concern. CSAC's assessment was broadly distributed to key interagency National Biosurveillance Integration Center stakeholders, and local, state, and federal fusion centers.



Oldsmar's Water Treatment Plant, Credit: myoldsmar.com



Phosphogypsum Stack, Credit: U.S. Department of Agriculture

"The information is good for our investigational leadership's awareness because this type of incident could also impact food, chemical, healthcare, pharmaceuticals, and other Supervisory Control and Data Acquisition (SCADA) controlled infrastructure."

– Division of Food Defense Targeting, Office of Regulatory Affairs, U.S. Food and Drug Administration

Phosphogypsum Stacks – Manatee County FL

CSAC developed a bulletin for S&T leadership on a potential water contamination situation from a wastewater concentration pond in Manatee County, Florida. On April 3, 2021, the Governor of Florida declared a state of emergency in Manatee County due to the potential of an imminent collapse of a wastewater pond, known as a phosphogypsum waste stack, at a phosphate fertilizer plant. Collapse of this phosphogypsum waste stack could have resulted in flooding the surrounding area with large amounts of wastewater contaminating local drinking water and waterways with toxic materials. CSAC's bulletin addressed the chemical considerations and concerns, S&T equities and ongoing actions, as well as future capabilities and actions available to S&T.

5

The Jack Rabbit Program

Understanding Large-Scale Chemical Releases

Each year, hundreds of millions of tons of chemicals like chlorine and ammonia are transported through U.S. population centers. Although these chemicals are essential, they are toxic and pose a risk to the public through accidental release or an act of terrorism. To better understand and address this risk, CSAC initiated the Jack Rabbit program.

Jack Rabbit I, conducted in 2010, involved a series of 1- to 2-ton outdoor chlorine and ammonia release trials involving a team of stakeholders from government, industry, and academia.



DTRA uses Jack Rabbit II data and findings to improve the HPAC model for large-scale releases of chlorine and other toxic inhalation hazard materials and chemicals.

Published the Chlorine Institute Pamphlet 74, which provides industry-wide best-practices guidance for chlorine safety and security.

Ammonia is the most produced and widely distributed toxic chemical in the United States. The growing ammonia market includes fertilizers, refrigerants, water treatment, and green energy, to name a few, with distribution through railways, waterways, and pipelines.

Exploring Impact, Mitigation, and Response Measures for Large-Scale Chemical Releases

Jack Rabbit II, continuing where Jack Rabbit I left off, was conducted in two phases in 2015 and 2016, with the execution of chlorine release trials of 5 to 20 tons.

These experiments were unprecedented and filled crucial knowledge and data gaps. Prior to Jack Rabbit I and II, large-scale chlorine releases had never been tested at volumes representative of rail cars, tanker trucks, barges, or bulk storage tanks.



Typical Rye Grass samples before (left) and after (right) testing exposure to chloride

Conducted laboratory studies with DEVCOM CBC to evaluate four classes of detection technologies (i.e., gas, colorimetric, electrical conductivity, and spectroscopic) for use with anhydrous ammonia.

Published a series of 18 articles in a special edition of the *Journal of Atmospheric Environment*.

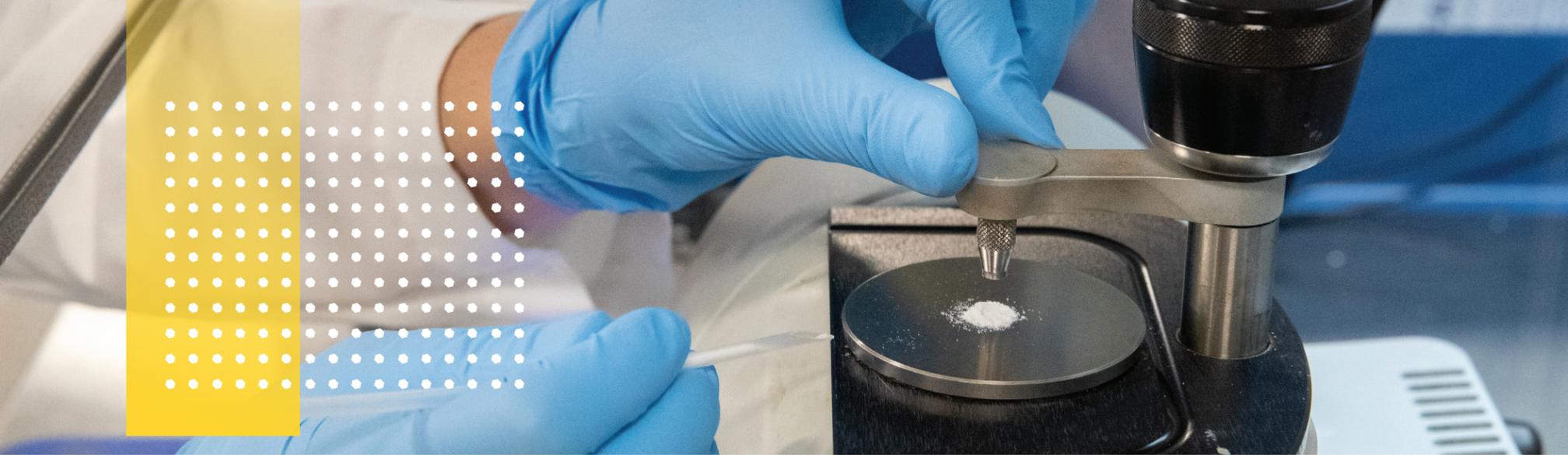
Established the Jack Rabbit III Scientific Advisory Group to provide scientific oversight of data quality, hazard prediction modeling, deposition and chemical reactivity, source terms, detection instrumentation, emergency response, and health and human effects.

Preparing for Safe, Green Energy

With Jack Rabbit III, which is focused on anhydrous ammonia, CSAC continues to improve hazard prediction modeling, emergency planning, and response and mitigation strategies, as well as the United States' resilience against chemical release incidents.



DHS S&T CSAC Jack Rabbit II Chlorine Release



Credit: Jerry Glasser, Customs and Border Protection

6

Priority Data Gaps Identified Using the Chemical RPM

To help decision makers prioritize research goals, CSAC launched Phase I of the Chemical Risk Prioritization Matrix (RPM) tool in 2019. Many thousands of input values in areas such as toxicity, medical mitigation, ease of production, and chemical and physical properties are needed as input to DHS S&T chemical risk assessments. The Chemical RPM identifies key parameters based on overall risk, parameter sensitivity, and level of confidence in the parameter. Data gaps are ranked based on these factors to ensure a systematic, defensible process is used to recommend funding for the highest value and most impactful research programs.

The first version of the Chemical RPM was completed this year containing 40 chemicals (of the 184 considered in the

risk assessments), representing over 84 parameters, all of which have been evaluated for data confidence based on the metrics developed with HAC-TC during Phase I of this work. The Chemical RPM has been updated with the most recent risk results generated with the PANTHR program, and is used to identify priority data gaps for the Chemical Threat Characterization (CTC) project. The phased development of this capability will continue in FY 2022 in conjunction with the PANTHR/Tools for Integrated Evaluation of Risk project to complete the evaluation of the remaining 144 chemicals. This capability provides DHS S&T a valuable resource to prioritize experimental and computational work to reduce uncertainty in the risk assessments and inform the important decisions based on those assessments.

7

Published the Synthetic Opioid MQL

CSAC, PANTHR, Office of Mission & Capability Support Opioid Program, and HAC-TC published the Synthetic Opioid Master Question List (MQL) in response to important opioid knowledge gaps. The MQL provides a simple interface of consolidated, scientifically vetted information in the context of daily operations and highlights the remaining critical knowledge gaps to focus investments with high operational priority and utility. It provides detailed, relevant science-based answers to operational questions on topics ranging from physical properties, exposure routes, decontamination protocols, deploying effective personal protective equipment, and detection. The MQL is a living repository of ongoing

research on synthetic opioids, updated annually or as key information emerges.

“Data confirms that America’s synthetic opioids epidemic is one of the biggest public health challenges of our time, poses significant hazards to emergency responders, and requires a whole-of-government response. We have pulled on every lever of our organization to develop a resource with the best scientific knowledge available to keep emergency responders safe.”

—DHS S&T

8

Enhanced Partnerships to Improve Chemical Security



Partnering with APHC

CSAC manages the Acute Exposure Chronic Effects (AECE) activity in collaboration with the Army Public Health Center (APHC) to study which threat agents may cause long-term effects from a single acute exposure. AECE provides the capability of estimating the long-term public health and economic impact from a chemical exposure.



Partnering with DEVCOM CBC

In close collaboration with the U.S. Army Combat Capabilities Development Command Chemical Biological Center (DEVCOM CBC), CSAC determined the final physical location of the Chemical Security Laboratory at the DEVCOM CBC facilities at Aberdeen Proving Ground, Maryland. CSAC's new laboratory will provide in-house capabilities for accomplishing mission-critical tasks on chemicals of interest to DHS. The laboratory will be leveraged to fill civilian chemical defense knowledge gaps and provide experimentally reliable data to projects and programs.



Partnering with USAR CMU

CSAC was invited by DEVCOM CBC to present new tools and findings to the U.S. Army Reserves (USAR) Consequence Management Unit (CMU). The CMU provides multi-disciplined consequence management expertise for Army, joint, and interagency operations. CMU soldiers are specially trained to provide technical analysis and advice to commands during consequence management and elimination operations. CSAC provided an overview and demonstration on the CARD, Intentional Adulteration Assessment Tool (IAAT), and Chemical Consequences and Threat Tool, part of the all-hazards CAPT WEB suite of tools. These tools assist law enforcement agencies and first responders with prevention and preparation for accidental and intentional events related to drug proliferation, food production, and release of toxic chemicals in civilian soft targets, areas aligned with the CMU mission. CSAC was honored by the USAR CMU with a Certificate of Appreciation for participating in this event.



HExCAT Market Surveys

CSAC, with the Technology Transfer and Commercialization Office and their partners, MilTech and SRI, conducted two market research studies to identify transfer partners for the Homeland Explosives Consequence and Threat (HExCAT) tool. SRI identified key potential end users and features of the tool that would increase the likelihood of a successful transition. MilTech identified industry segments such as sporting venues and public transportation associations who would be probable candidates for use of a *For Official Use Only* version of the software. MilTech and SRI provided valuable support and insight to enable transition planning for this new capability.

IAAT Market Demand Assessment

CSAC partnered with MilTech to determine the IAAT's market demand for improving food defense for U.S. food manufacturers. This information helps decide whether to invest in software refinements and establish a hosting platform. A combination of companies, consultants, and trade associations were identified for 17 in-depth interviews using an online survey conducted by MilTech. Trade associations also agreed to distribute the survey to their members, resulting in over 120 additional replies. Survey results concluded the IAAT can play a supporting role in developing food manufacturers' initial and ongoing food defense activities and that a cloud-based platform would maximize its food defense effectiveness.



Partnering with USAMRICD

In FY 2020, CSAC developed a partnership with the U.S. Army's Medical Research Institute of Chemical Defense (USAMRICD) to initiate organoleptic and dermal experimental activity for the CTC Solubility, Toxicity, and Organoleptic Profile of Toxic Industrial Chemicals (STOP-TIC) program to determine organoleptic limits and oral and dermal toxicity of high-priority materials to the Homeland. The STOP-TIC collaboration supports the PANTHR program and leverages the best capabilities and expertise to provide critical data on intentional contamination of food or surfaces with toxic chemicals.

In August 2021, the results of the first study completed by USAMRICD, as part of the STOP-TIC program with CSAC, were published.



Partnering with IWTSD

The Irregular Warfare Technical Support Division (IWTSD) and their partners in Australia, with guidance from CSAC, measured the skin permeation coefficients of priority compounds, including select opioids. This work filled critical data gaps in the analysis of risk from contact hazards in public spaces for the PANTHR program. Additionally, CSAC reviewed analytical methods and interpreted data for the stability and decontamination studies for pharmaceutical-based agents, another critical data set for first responders which is now included in the CSAC interagency Non Traditional Agents Library.



Credit: Mark C. Olsen, New Jersey National Guard

9

Evaluated the Portability of MFDs

Currently available chemical, biological, radiological, nuclear, and explosives (CBRNE) detection technologies do not meet operational needs with respect to portability. The ideal threat detector, a small, user-friendly device, will protect the lives and health of emergency responders (e.g., U.S. Coast Guard, Customs and Border Protection Maritime Operations, and the U.S. Secret Service) by providing trustworthy warnings to the presence of threats in a format that does not impede operations or mission. To this end, CSAC conducted a literature survey of potential component technologies with a focus on five miniaturization enablers: aerosol and vapor sampling, spectroscopy-based detection, nanomaterial-based detection, separation science, and spectrometry-based detection. An SME was selected for each of the five miniaturization approaches to assess technologies and provide a semi-quantitative estimate of metrics.

Specific accomplishments from the Multi Functional Detectors (MFD) project include:

- Developed advanced detection concepts in partnership with the Homeland Security Systems Engineering and Development Institute. The work involved combining available technologies and is the first step to realizing an operational MFD.
- In partnership with MilTech, engaged with academic and industrial SMEs to assist in assessment of new state-of-the-art technologies. The SMEs provided insight on which technologies were most capable and easily produced and integrated into detection systems, thus expediting their development into affordable and available devices that emergency responders can use.
- Preliminary results were provided to the DHS CWMD Acquisition and Research & Development Divisions.
- Developed a detailed report, Market Survey of CBRNE Detection Systems and Relevant Components for Compact Multifunctional Detectors, on high technology readiness level chemical hazard detection systems currently on the market.

Enabling CSAC Expertise

During a year of working virtually, CSAC experts remained focused on engagements and partnerships, while expanding core portfolio areas of expertise. In FY 2021, CSAC SMEs hosted, provided briefings, and conducted demonstrations at nearly 60 events with federal, international, and industry stakeholders. As recognized experts, CSAC presented at the December 2020 Chemical Sector Security Seminars, the 24th Annual George Mason University Conference on Atmospheric Transport and Dispersion, and the International Association for Food Protection Conference, to mention a few. CSAC also advised and provided expertise to many ongoing working groups, such as the Interagency COVID-19 Transportation Working Group, Chemical Incident Consequence Management Group, and the Gas Forming Reactions Working Group. Aligned with S&T's Vision and Guiding Principles, CSAC continues to enable and manage staff expertise to drive the science, deliver solutions, and help ensure the security of the nation.



LEARN MORE

<https://www.dhs.gov/science-and-technology/csac>

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