



Chemical Security Analysis Center

**FISCAL YEAR (FY) 2020
ANNUAL REPORT**



**Homeland
Security**

Science and 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 meaningful assessments, recommendations, and forecasts based on vetted data




- Identifying, prioritizing, and addressing data gaps through high quality chemical research, development, test, and evaluation

CSAC OVERVIEW



Chemical Safety Board releases investigative report of 2003 Arizona chlorine accident

Kansas: Methomyl contamination in salsa




Texas: Ammonium nitrate explosion at fertilizer plant



West Virginia: Major methylcyclohexyl methanol spill



Tennessee: Train accident causes acrylonitrile leak that catches fire




Brodifacoum food adulteration incident

Skripal poisoning



Navalny poisoning

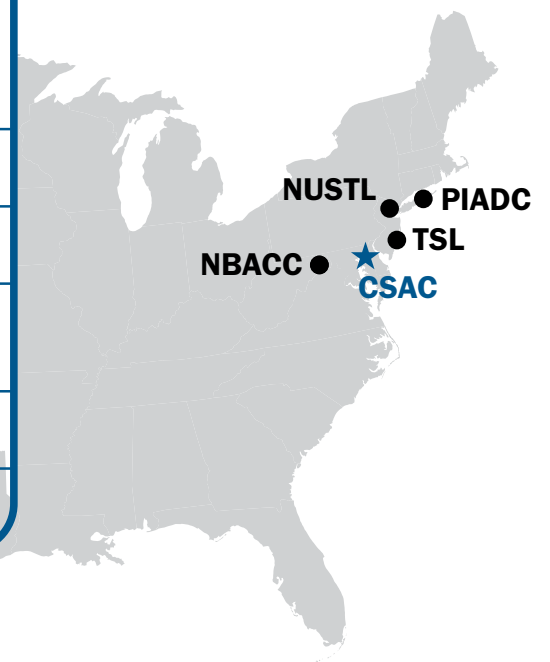
United States: 1,800 pounds of fentanyl seized as Opioid Crisis escalates



DHS S&T LABORATORIES

The Office of National Laboratories provides specialized technical expertise and world-class research facilities to DHS and other partners.

CSAC	Chemical Security Analysis Center
NUSTL	National Urban Security Technology Laboratory
NBACC	National Biodefense Analysis and Countermeasures Center
PIADC	Plum Island Animal Disease Center
TSL	Transportation Security Laboratory



Customer	FY2020 Major Customer Engagements
DHS CISA Cybersecurity and Infrastructure Security Agency	Quantitative Threat Modeling to inform Chemical Facility Anti-Terrorism Standards Tiering Methodology
DHS CWMD Countering Weapons of Mass Destruction	Chemical Defense Strategic Implementation Plan
DHS TSA Transportation Security Administration	Gas Forming Reactions and Airplane Modeling
DOD CTTSO Department of Defense Combating Terrorism Technical Support Office	Databases and Data Architecture
DOD DTRA Defense Threat Reduction Agency	Atmospheric and Dispersion Modeling and Source Term Analysis
USDA United States Department of Agriculture	Food Defense Targeted Analysis

1

Aviation Modeling Assessed the Impact of SARS-CoV-2 on Commercial Aircraft

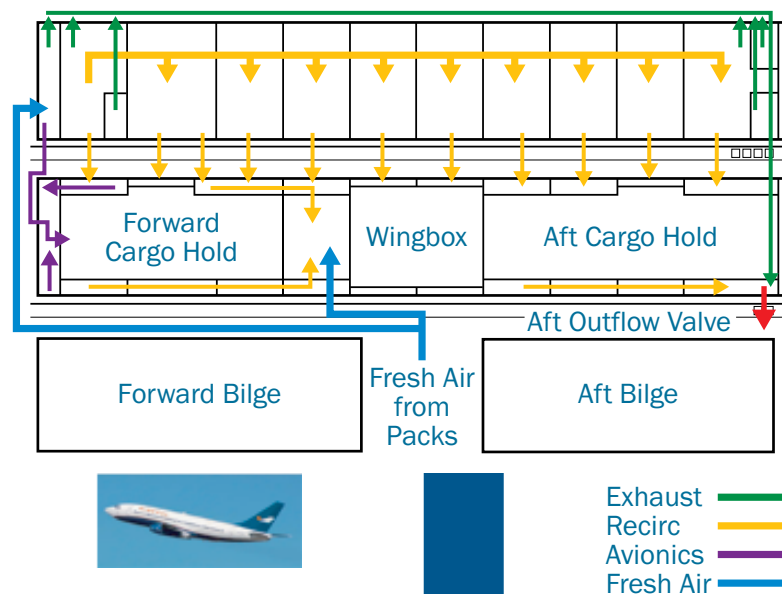
CSAC applied previously developed and validated multi-zone models for chemical contamination in aircraft to understand the transmission of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) on commercial aircraft. These models were developed in conjunction with the United Kingdom (UK) Centre for the Protection of National Infrastructure, the UK Department for Transport, TSA, and CTTSO, using the National Institute of Standards and Technology CONTAM software. Select potential mitigation measures such as the use of High Efficiency Particulate Air filtration, adjustment of air flow exchange rates, and universal mask wearing were evaluated for the impact on passenger exposure given a single contagious passenger and multiple contagious passengers on a flight.

Through the DHS S&T Probabilistic Assessment of National Threats Hazards and Risks (PANTHR) program and the DHS S&T Hazard Awareness Characterization Technology Center (HAC-TC), key parameters such as the rate of viral shedding and the particle size distribution for common activities such as breathing, talking, and coughing were estimated based on an extensive literature review. The study included estimates for the emission of both small aerosols, which are most useful for characterizing the airborne hazard and impact of filtration systems, and larger droplets, which are most important for characterizing surface contamination.

The results of this study have been used to evaluate potential mitigation measures to help decrease the risk of pathogen transmission during air travel.



PHOTO: guvendemir

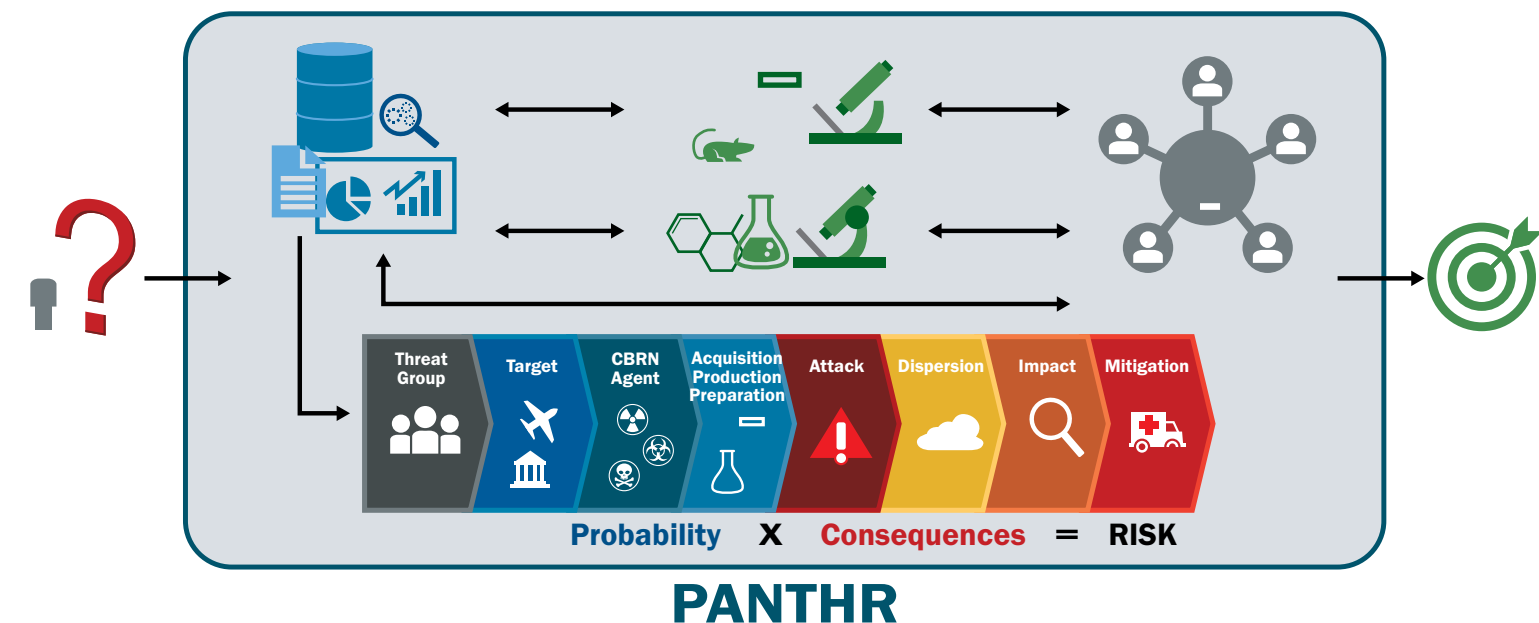


2

PANTHR CTC Project Established

CSAC established the Chemical Threat Characterization (CTC) project, one of five projects of the DHS S&T strategic PANTHR program, to experimentally address priority data gaps to enhance the assessment of chemical risk to the U.S. homeland. Contamination of the food supply and high touch surfaces are two areas previously identified as important contributors to chemical risk. To reduce uncertainty and better characterize these risks, CSAC developed a partnership with the U.S. Army Medical Research Institute of Chemical Defense to experimentally determine organoleptic limits of high priority materials in select food matrices. This work will better identify which materials could be covertly added to the food matrices at toxic levels without noticeably altering the taste, smell, or appearance of the food.

The oral toxicity of these materials will be determined to better evaluate risk and focus target detection and security measures in the food supply chain. Dermal toxicity will also be characterized to better evaluate the risk from intentional and accidental surface contamination. This effort, collectively known as the Solubility, Toxicity and Organoleptic Profile of Toxic Industrial Chemicals, will provide critical data to be incorporated into the PANTHR Tools for the Integrated Evaluation of Risk food and dermal models, enhancing these capabilities.



CSAC SCIENTISTS RECOGNIZED FOR THEIR EXPERTISE

3 CBRN Canister Protection Capabilities Evaluated Against Emerging Hazards

In the event of a chemical, biological, radiological, or nuclear (CBRN) hazard release, emergency responders rely on respiratory protection to prevent inhalation exposure to these hazards. The National Institute for Occupational Safety and Health (NIOSH) evaluates CBRN air-purifying respirator (APR) canisters by challenging the respirator filter media and carbon bed to 11 test representative agents (TRAs) representing different chemical families. This approach, dating back to the original 2001 CBRN hazard assessment, is still in use today. CBRN hazards, however, are constantly evolving in type, usage, and dissemination. The need was identified to evaluate the CBRN hazard assessment to ensure existing NIOSH-approved CBRN APR canisters continue to provide adequate protection from newly emerging chemical and radiological hazards. In response, NIOSH partnered with the U.S. Army, Combat Capabilities Development Command, Chemical Biological Center (DEVCOM CBC), the U.S. Naval Research Laboratory (NRL), and CSAC to conduct an updated CBRN hazard assessment.

Recent chemical hazard assessments were reviewed to generate a comprehensive list of potential chemical and radiological hazards that would be relevant to emergency responders. An evaluation process was developed to assess this new list of chemicals for consideration as new NIOSH CBRN TRAs. In partnership with the Centers for Disease Control and Prevention National Center for Environmental Health, and the Office of Public Health Preparedness and Response Senior Advisor for Lab Preparedness and the Senior Advisor for Medical Countermeasures, the project team (NIOSH, DEVCOM CBC, NRL, and CSAC) convened a panel that developed a consensus position in the classification of the emerging chemical and radiological hazards.

Ultimately, it was determined that the current NIOSH TRAs adequately represented all chemical and radiological hazards identified in the updated CBRN Hazard Assessment, and there was no need to update the TRAs at this time. The process standardized a methodology to evaluate future hazards. Results have been disseminated and will be used as the basis to update NIOSH publications, including the NIOSH CBRN Respiratory Protection Handbook and existing guidance regarding the capabilities of the CBRN APR.

JESSICA COX & DR. DAVID BRADLEY RECEIVED 2020 INTERAGENCY PARTNERSHIP AWARD FROM THE MID-ATLANTIC REGION OF THE FEDERAL LABORATORY CONSORTIUM FOR TECHNOLOGY TRANSFER



DR. DAVID BRADLEY PRESENTED BULLARD-SHERWOOD RESEARCH TO PRACTICE AWARD



JESSICA COX ACKNOWLEDGED FOR EXTENSIVE CONTRIBUTIONS IN DEVELOPMENT OF THE U.N.'S FAO GUIDE TO RANKING FOOD SAFETY RISKS AT THE NATIONAL LEVEL

“ I am excited to see the output of everyone’s labors and finally see this guidance through to publication ”

— Jessica Cox

4 Emerging Synthetic Opioids Identified

CSAC led multiple efforts researching and developing knowledge products characterizing the threat from pharmaceutical based agents such as fentanyl. In particular, the 2019 Illicit Opioid Threat Prioritization and Prediction report was developed that identified a list of current and future opioids posing the greatest risk to the country. The report and novel threat analysis methodology are critical tools DHS is using to combat the opioid crisis, enabling enhanced targeting, detection, and interdiction of synthetic fentanyl compounds by law enforcement and Customs and Border Protection. The impact this innovative approach plays in stemming the flow of these extremely dangerous compounds into communities ravaged by fentanyl and other synthetic opioids will ultimately be measured in saved lives.

5 S&T CSAC Expanded Role in the Nation’s Food Defense

In 2016, CSAC scientists provided subject matter expertise which would culminate in the release of the Food and Agriculture Organization (FAO) of the United Nations (U.N.) *FAO Guide to Ranking Food Safety Risks at the National Level*. RTI International facilitated a workshop to collect information and content needed to develop this guide. Jessica Cox provided subject matter expert (SME) guidance leading up to the workshop, including briefings on CSAC’s food defense efforts and risk assessments as well as the key attributes to the risk equation in the food mission space. She also participated in the workshop that finalized the content of the report through consensus discussions.

The objective of this guidance is to provide direction to national food safety authorities on how to rank the public health risk posed by foodborne hazards in their countries. The guidance focuses on the ranking of microbial and chemical hazards based exclusively on their impact on public health, and represents the first step toward a systematic and evidence-based approach to identify the most significant risks in food safety. This publication has been shared with food defense industry stakeholders to propagate global guidance.

DR. CAROL BREVETT WINS WOMEN OF COLOR SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) AWARD FOR OUTSTANDING TECHNICAL CONTRIBUTION TO GOVERNMENT



“ She brings a wonderful diversity of thought, culture, and experience to our team that truly lifts us up, makes us better, and brings us closer together. ”

— Dr. Shannon Fox, Director, DHS S&T CSAC

Dr. Carol Brevett is a lead scientist and SME in CSAC’s CTC team. She leads CSAC’s Food Defense program and has developed a novel probabilistic risk assessment model to analyze, assess, and mitigate the risk of chemical attacks on the nation’s food supplies. To develop the model and mitigate the threat, Dr. Brevett forged unique partnerships with major private sector companies in the food industry to design key elements of the food preparation and distribution process into the model. The model has become an invaluable tool used to assess and mitigate chemical threats to food by DHS and was used to provide supportive calculations for the Food and Drug Administration’s Food Safety Modernization Act guidance.

6

Provisional Patent for Saliva Test Strip for Cyanide Exposure Granted

Every year more than 3,000 Americans die and more than 14,000 are injured from fires in the United States. The most common cause of death is the inhalation of toxic gases rather than thermal injury. Cyanide is known to play a significant role in smoke inhalation injury and death. The medical and first responder communities need the ability to rapidly identify exposure to cyanide in order to treat victims more effectively and efficiently.

Cyanide poisoning is difficult to measure in an exposed individual by using current blood testing analysis techniques. Additionally, while timely administration of a cyanide antidote is important to treat the exposed individual, the high cost of \$1,000 per dose makes it difficult to prophylactically treat without more reliable proof that the individual has been poisoned by cyanide.

CSAC identified a rapid method to test for cyanide exposure in saliva. The innovation embodies an on-scene test to presumptively determine if a victim has inhaled a dangerous amount of cyanide gas by measuring the substances thiocyanate and methemoglobin. Thiocyanate is formed as a metabolite by the body during natural detoxification of cyanide. Additionally, a substantial reduction of methemoglobin also indicates exposure to cyanide. Combined, these two indicators can be rapidly measured to indicate cyanide exposure requiring targeted treatment.

With this invention, a saliva sample from a potentially exposed person can be placed in contact with a chemical indicator that will show, in conjunction with pulse oximetry measurements, whether a high-level cyanide exposure has occurred. First responders and victims of building fires and hazardous materials incidents will receive an antidote sooner and lives will be saved. The single most important factor driving successful conversion of a potentially lethal exposure of cyanide into full recovery is timeliness of rescue.



PHOTO: DVIDS



PHOTO: Light Field Studios

7

Chemical Hazard Assessment Delivered to NYPD for the Times Square NYE Celebration

In December 2019, CSAC delivered a tailored chemical hazard assessment for the New York Police Department (NYPD) for the New York City New Year's Eve (NYE) celebration in Times Square. CSAC scientists helped the NYPD craft risk-based scenarios to understand the impact of an accidental or intentional chemical release during the NYE celebrations. Then, 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.

The study assessed a release from multiple types of sources, including local hazards from chemical transportation and facilities. Calculations to determine the adverse effect of airborne chemicals released from a location outside of the event exclusion zone were performed using the standard DTRA Hazard Prediction Assessment Capability (HPAC) software. Additionally, human-portable aerial and ground scenarios were simulated with the Urban Dispersion Model in HPAC, which accounts for the dispersion and channeling of airflow by buildings. Public health consequences were calculated using the methodology developed for CSAC's Inhalation Consequence Model.

The assessment was used by the NYPD as a critical planning tool. In addition, CSAC provided HAC-TC with the scenarios and modeling files needed for an expanded analysis. HAC-TC then delivered a complementary biological assessment to NYPD for the event. This was a great example of enhancing deliverables, exceeding the customer's expectations, and demonstrating cohesive and collaborative work within DHS S&T to provide integrated analyses.



PHOTO: Simon Dux



PHOTO: Molina86

CSAC FY 2020 PROGRAM ACCOMPLISHMENTS

8

24/7 Technical Assistance Provided Real-Time Scientific Expertise

The CSAC Technical Assistance Capability is a 24/7 science and technology based service which provides chemical threat, hazard, and risk information and expertise to interagency partners and customers throughout the Homeland Security Enterprise. The Capability operates at all levels of information sensitivity from unclassified to Top Secret. The Technical Assistance Capability addresses numerous types of requests for information, from emergencies and planning for high-risk events to assisting in long-term planning to lessen the risks associated with chemical disasters or terrorist actions.

Hurricane Response

CSAC provided around the clock surveillance of the most active Atlantic hurricane season on record. The 2020 season included 30 named storms, 13 of which developed into hurricanes. CSAC provided local and regional chemical hazard and vulnerability information to inform federal, state, territorial, tribal, and local responder groups in preparation of hurricane landfall that could impact the safety or security of chemical facilities or transport systems and the surrounding populations. CSAC researched and identified chemical facilities in the predicted paths of major hurricanes Laura, Zeta, and Eta. Following the landfall of Hurricane Laura, CSAC was contacted about a chemical fire and a report of a potential release of trichloroisocyanuric acid, and its chlorine gas precursor, at BioLab in Lake Charles, Louisiana. CSAC supported the emergency response efforts with identification of likely hazards at the facility, including additional toxic chemical precursors and the impact to the surrounding population.

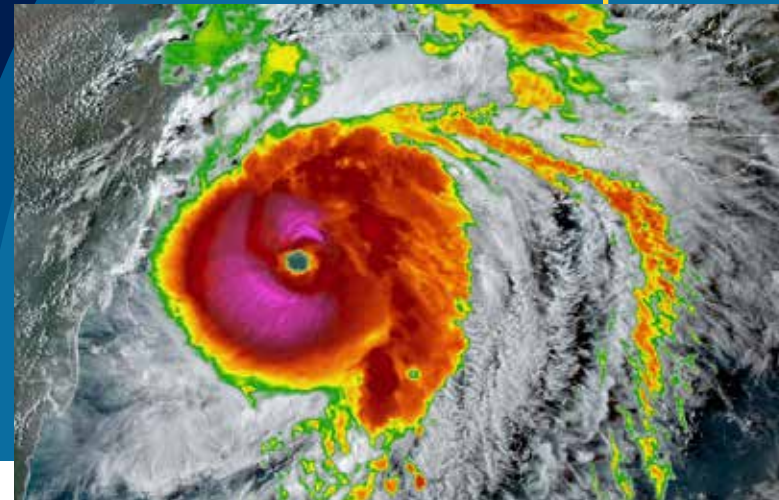


PHOTO: NOAA/NASA

ANALYSIS OF CHEMICAL FACILITIES IN HURRICANE PATH

FOCUSED CHEMICAL FACILITY EMERGENCY RESPONSE EFFORTS



PHOTO: United States Chemical Safety Board (csb.gov)

Strategic Analysis of Opioids for Intelligence Community

There is a continued need to support law enforcement and the intelligence community (IC) in their efforts to thwart the flow of illicit drugs, particularly synthetic opioids and their precursors, into the United States. A customer in the IC engaged CSAC Technical Assistance to provide a comprehensive list of all chemical precursors required to prepare high-risk synthetic opioids from multiple synthetic pathways, considering domestic and foreign preferred production, and emergent analogues. The customer incorporated CSAC's product, in concert with other tracking methods, to enhance interdiction efficiency of chemical precursors of high-risk synthetic opioids. Realizing this information would benefit the larger chemical threat community, CSAC also developed several knowledge products to serve as resources for detection and interdiction of illicit opioids:

- Fentanyl Synthesis Quick Reference Guide
- Nitazene Benzimidazole Opioid Synthesis Quick Reference Guide
- Memorandum for Record 2.0: Illicit Drug Threats



PHOTO: United States Customs and Border Patrol

EXPANDED CORE TECHNICAL RESOURCES

Chemical Agents Reactions Database (CARD)

The CARD is a powerful tool CSAC developed to analyze chemical reactions and synthetic pathways of the Nation's most dangerous chemical threats, such as chemical warfare agents, synthetic opioids, and other emerging threats. It features more than 2,000 chemical reactions, cross-searchable by reactants, products, precursors, and structures, and provides CSAC's stakeholders with accurate, comprehensive, and actionable data for chemical threat forensics and attribution. CARD versions 9 and 10 were completed in FY 2020, enhancing user operability with a Boolean operator search routine capability, and expanding the tool's references, chemical reactions, and list of chemicals with properties for 60 new threat chemicals.



PHOTO: US Coast Guard

Homeland Explosive Consequence and Threat Tool (HEXCAT)

In conjunction with the Homemade Explosives Identification, Detection and Mitigation Program, and with SME input from the HAC-TC, CSAC is developing a modeling tool called HEXCAT that estimates the hazard and related human health consequences from a multitude of plausible scenarios using an explosive device. The HEXCAT utilizes enhanced distributions for key performance parameters to reflect the inherent uncertainty of these events and incorporates multiple geospatial resources to enable rapid scenario generation with minimal input data requirements. The consequence tool is being integrated with medical response models which allows assessment of the current ability to respond and identifies resource or personnel chokepoints in the effective delivery of on-site and hospital care. The HEXCAT will be integrated into the All-Hazards Countermeasure Assessment and Planning Tool (CAPT Web).



PHOTO: Aaron Tang, CC-BY-2.0



PHOTO: Georgethefourth/iStock

Non-Traditional Agent (NTA) Data Management Library

CSAC manages and maintains the United States Government's largest NTA Data Management Library. The library was expanded in FY 2020 to include more than 20,000 data points related to the toxicity, chemical and physical properties, and countermeasures for emergent toxic chemical threats. The library now features over 637 documents, and the classified version of the virtual library includes expanded data matrices and new technical documents, such as whitepapers and material threat assessments. The data matrices are updated quarterly to ensure researchers, acquisition managers, and policy makers can make informed decisions using the most recent and complete information available.

Chemical Current News Report

In FY 2020, CSAC significantly expanded the distribution and readership of the Chemical Current News Report, which is compiled daily from domestic and foreign open-source information pertaining to chemical threats and critical infrastructure. The report's content is curated by a CSAC team led by Dr. George Emmett, an SME with more than 50 years of chemical experience, who vets the information and provides context for an insightful report. Over time, trends are observed to determine chemical defense related areas of concern. In addition to the report being distributed daily via email, it is now also posted to the Drug Monitoring Initiative Community of Interest on the Homeland Security Information Network, the circulation of which is greater than 1,000 regular readers.



Chemical Consequence and Threat (CCAT) Tool/CAPT Web

CSAC continued to leverage the CCAT Tool, part of S&T's All-Hazards CAPT Web, a rapid desktop analysis platform based on models, data, and the calculation engine developed for the comprehensive CBRN risk assessments. These assessments support multiple component requests, technical reachback, and internal sensitivity analyses to identify high priority data parameters. The CCAT Tool calculates the expected lethal and sub-lethal consequences of a chemical release in indoor and outdoor spaces as well as in food and water and due to surface contamination. The Tool also identifies bottlenecks and resource constraints which impact the ability of first responders to deliver care and save lives during a chemical event. Maintenance and upgrades for the Tool transitioned to the PANTHR program with active support from CSAC and HAC-TC.

LEARN MORE

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

CONTACT US

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1	2											13	14	15	16	17	18	19
3	4											5	6	7	8	9	10	11
Li Lithium 6.941	Be Beryllium 9.012											B Boron 10.811	C Carbon 12.011	N Nitrogen 14.007	O Oxygen 15.999	F Fluorine 18.998	Ne Neon 20.180	
11	12											13	14	15	16	17	18	
Na Sodium 22.990	Mg Magnesium 24.305											Al Aluminum 26.982	Si Silicon 28.086	P Phosphorus 30.974	S Sulfur 32.065	Cl Chlorine 35.453	Ar Argon 39.948	
		3	4	5	6	7						12						
19	20	21	22	23	24	25						30						
K Potassium 39.098	Ca Calcium 40.078	Sc Scandium 44.956	Ti Titanium 47.867	V Vanadium 50.942	Cr Chromium 51.996	Mn Manganese 54.938						Zn Zinc 65.38	Ga Gallium 69.723	Ge Germanium 72.631	As Arsenic 74.922	Se Selenium 78.971	Br Bromine 79.904	Kr Krypton 83.798
		39	40	41	42	43	44	45	46	47	48							
37	38	39	40	41	42	43	44	45	46	47	48							
Rb Rubidium 85.468	Sr Strontium 87.62	Y Yttrium 88.906	Zr Zirconium 91.224	Nb Niobium 92.906	Mo Molybdenum 95.94	Tc Technetium 98.906	Ru Ruthenium 101.07	Rh Rhodium 102.906	Pd Palladium 106.42	Ag Silver 107.868	Cd Cadmium 112.411							
		57-71	72	73						80	81	82						
55	56	57-71	72	73						80	81	82						
Cs Cesium 132.905	Ba Barium 137.328	Lanthanoids	Hf Hafnium 178.49	Ta Tantalum 180.948						Hg Mercury 200.59	Tl Thallium 204.383	Pb Lead 207.2	Bi Bismuth 208.980	Po Polonium (209)	At Astatine 209.987	Rn Radon 222.018		
		89-103	104						112			114	115	116	117	118		
87	88	89-103	104						112			114	115	116	117	118		
Fr Francium 223.020	Ra Radium 226.025	Actinoids	Rf Rutherfordium (261)						Cn Copernicium (285)			Fl Flerovium (289)	Mc Moscovium (289)	Lv Livermorium (293)	Ts Tennessine (294)	Og Oganesson (294)		

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La Lanthanum 138.905	Ce Cerium 140.116	Pr Praseodymium 140.908	Nd Neodymium 144.242	Pm Promethium 144.913	Sm Samarium 150.36	Eu Europium 151.964	Gd Gadolinium 157.25	Tb Terbium 158.925	Dy Dysprosium 162.500	Ho Holmium 164.930	Er Erbium 167.259	Tm Thulium 168.934	Yb Ytterbium 173.055	Lu Lutetium 174.967
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Ac Actinium 227.028	Th Thorium 232.038	Pa Protactinium 231.036	U Uranium 238.029	Np Neptunium 237.048	Pu Plutonium 244.064	Am Americium 243.061	Cm Curium 247.070	Bk Berkelium 247.070	Cf Californium 251.080	Es Einsteinium [254]	Fm Fermium 257.095	Md Mendelevium 258.1	No Nobelium 259.101	Lr Lawrencium [262]



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