




ABSTRACTS

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PLENARY SESSION

Welcome

Erin Silvestri-Nierner, Conference Co-Chair | *U.S. Environmental Protection Agency*

Michael Pirhalla, Conference Co-Chair | *U.S. Environmental Protection Agency*

Judy Ancharski, Conference Co-Chair | *U.S. Environmental Protection Agency*

Viktoriya Plotkin, Conference Co-Chair | *U.S. Environmental Protection Agency*

Introduction

Lance Brooks, Homeland Security & Materials Management Division Director | *U.S. Environmental Protection Agency*

Opening Remarks

Shawn Ryan, Homeland Security Research Program Director | *U.S. Environmental Protection Agency*

EPA Speaker

Maureen Gwinn, Office of Research and Development Principal Deputy Assistant Administrator | *U.S. Environmental Protection Agency*

Plenary Talk 1: Joint USCG/EPA Responses and Demonstrations

Dana S. Tulis, Director of Incident Management and Preparedness Policy | *U.S. Coast Guard*

The discussion will include joint EPA and USCG authorities, proven site characterization and response procedures for a *Bacillus anthracis* response (ANCOR 5 year demo), and ongoing efforts at Lahaina, Maui and furthering the use of UAS.

Plenary Talk 2: Integrating Scientific Resources into the East Palestine (Ohio) Train Derailment Emergency

Mark Durno, Federal On-Scene Coordinator | *U.S. Environmental Protection Agency*

On February 3, 2023, a major train derailment and fire involving several tank cars of hazardous materials occurred in East Palestine, Ohio. The initial fire was under control within two days of the incident; however, due to pressure and temperature increases in at least one railcar, a “vent and burn” operation of five vinyl chloride tank cars was conducted on February 6th. Over the course of the next week, the visual images of the vent and burn became a world-wide story. Although sound science and a robust air monitoring and sampling program indicated that risks to public safety were minimal, concerns remained high among community members and leaders. To support local and surrounding communities, EPA and its Unified Command partners brought expert support and front-line technology to the incident to ensure that risks to the public were



minimized. The cleanup efforts and full-site characterization will continue into early 2024. This presentation will focus on the overall response and many technical, community, and response management challenges that were faced and the tools that were used to overcome them.

CONCURRENT SESSION 1 – CHEMICAL AGENTS: DECONTAMINATION I

Full-scale Testing of a Simulated Chemical Warfare Agent Contamination Response

Lukas Oudejans | *U.S. Environmental Protection Agency*

The EPA is enhancing the nation's ability to respond to and recover from a chemical warfare agent (CWA) incident through research to develop environmental countermeasures and response exercises/training. Recently, researchers and responders were brought together to conduct the Operational Testing and Evaluation of Chemical Remediation Activities (OTECRA) field study. Activities included an initial contamination event, pre-decontamination sampling, decontamination, post-decontamination sampling, with waste and data management conducted throughout the exercise.

Malathion was applied as a CWA simulant across the floor and walls. Sampling teams conducted pre-decontamination sampling to establish the concentration of malathion on contaminated surfaces. Sampling was conducted with cotton gauze wipes and then analyzed on-site by EPA's Portable High-throughput Integrated Laboratory Identification System (PHILIS). Larger floor samples were collected using a wet-vacuum composite sampling approach. Once decontamination of the building interior was finished, sampling teams conducted post-decontamination sampling. Two rounds of testing were conducted during the field study to evaluate different decontamination approaches. For the first round, Decon7, an activated hydrogen peroxide containing product, was applied using a low-pressure spraying system. The second round of testing involved the spraying of undiluted bleach. Prior to leaving the exclusion zone, responders and equipment were decontaminated to minimize the potential for cross contamination and introduction of the contaminant to areas outside the exclusion zone. Samples throughout the exercise were closely managed with the use of a QR code attached to each container that was scanned in the field and lab. Electronic tablets were used by samplers to scan the ID and input information into ESRI's Field Maps application on collection method, sample type, sample matrices, start and end times, observations, and photographs of the sample location. All waste generated during OTECRA was contained, segregated, and staged for characterization, sampling, and disposal. Information from sampling and analysis on how well the decontaminant performed was used to develop waste acceptance criteria and material disposal options. Testing remediation activities in a realistic scenario provides greater confidence in the success of an actual remediation performance.

Development of a Chemical Decontaminant for Critical Areas

Janlyn Hope Eikenberg | *U.S. Army*

Toxic chemical release, either accidental or deliberate, is a deadly, tragic, and chaotic event. Contamination of key points of infrastructure, including airports and seaports, can hinder life-saving response by medical and military personnel and can slow evacuation efforts. This program aims to develop a rapid, cost effective way of decontaminating large scale infrastructure and minimize the risk for vehicles and personnel which must traverse through a contaminated area. Use of traditional decontaminants is not feasible for wide area applications due to cost, preparation, storage, and efficacy limitations associated with scale up. This work explored the use of reactive formulations based on widely available commodity chemicals for direct remediation and the use of chemically used agricultural and construction polymers for encapsulation of the contaminant. A large variety of reactive chemicals were screened for their ability to remove chemicals from concrete and asphalt surfaces. The best performers were then downselected based on logistics considerations, including price, environmental impact, health and safety, scalability, and material compatibility. Of these chemicals, peroxydisulfate oxidants provided the best profile of efficacy and logistics over other chlorinated oxidants and caustic bases. Current efforts focus on refining and evaluating a formulation based on



these underlying chemistries. Barrier polymers for encapsulation have been studied and evaluated by testing the reduction in the contact (dermal) hazard and vapor (inhalation) hazard. Polymers such as bitumen sealcoats, acrylic soil stabilizers and methyl cellulose stockpile sealant proved to be moderately effective at encapsulation of contaminated concrete and asphalt. Both encapsulation and direct remediation are being further explore as options for chemical critical area decontamination. This technology aims to fit an unfilled need and enable first responders, victims and military personnel to more safely operate in a contaminated environment.

Chemical Hot Air Decontamination: The Effect of Elevated Humidity

Joseph Myers | *U.S. Army*

Funded by the Defense Threat Reduction Agency (DTRA), Chemical Hot Air Decontamination (CHAD) is a method of decontamination which uses heat and humidification to remove/detoxify the contaminants from assets without the need for harsh chemicals, such as bleach or caustic. CHAD requires contaminated items to be placed inside an enclosure that can be heated and humidified, which has air flowing through to allow any evaporated contaminants to be removed.

The Decontamination Sciences Branch (DSB) of US Army Combat Capabilities Development Command (DEVCOM) Chemical Biological Center (CBC) has utilized CHAD in small-scale laboratory studies as a method of removing contamination from absorptive surfaces, complex features, and realistic small items.

Humidification up to 95% RH at 170°F (~243 g water/m³ air) have been evaluated. CHAD has been shown to remove a significant amount of contamination from materials within 8 h.

Active Matter for Chemical Decontamination

Eric Languirand and Matthew Collins | *U.S. Army*

Micromotors are one type of active matter that can achieve motion on the micro-scale by converting chemical energy into mechanical movement. Active matter provides greater movement than what is provided typically through Brownian motion. This increase in movement provides more opportunities for the active matter to interact with an analyte of interest to increase the kinetics of reactions such as decontamination to remove hazardous chemicals. One technique to decontaminate a solution is to employ metal-organic frameworks (MOFs) that have been robustly studied. Here, we seek to combine active matter and MOFs to more quickly decontaminate a solution containing chemical agent.

We synthesize UiO66 as an active matter particle for decontamination via a SiO₂@UiO66@Pt or SiO₂@UiO66@Ag stratified particle. The SiO₂ base particle is used to define the size and shape of the UiO66 active matter to better control the mechanism of propulsion. We show significantly greater movement speed than Brownian motion with both bubble and electrophoretic propelled MOF-based active matter. Additionally, we show the ability of active matter to reduce the overall decontamination time of a simulant and a chemical warfare agent by increasing the decontamination reaction kinetics. Overall, these MOF micromotors can be used in the future to decontaminate hazardous chemicals.

CONCURRENT SESSION 1 – MATERIALS AND WASTE MANAGEMENT

Best Practices to Improve the Resiliency of Disaster Waste Management

Amy Schwarber Krause | *U.S. Environmental Protection Agency*

Extreme weather events make it critical for communities to plan for effectively managing large quantities of disaster waste and debris while maintaining their ability to receive everyday municipal waste. Recent disasters (floods, hurricanes, earthquakes, tsunamis, fires, volcanoes, landslides, tornadoes, winter storms, and dust storms) create environmental impacts, social hardships, economic costs, and a tremendous amount of waste. For example, Wakabayashi et al. (2017) projected that a probable earthquake and accompanying tsunami can



create 52 times the amount of municipal solid waste generated in a standard year. In addition, climate change impacts waste infrastructure, and communities will need to adapt as the amount, frequency, and severity of disasters increase. This presentation summarizes a literature review that answers questions regarding what has been successful in helping communities not only manage disaster waste but also become more resilient to disasters. It also provides an up-to-date summary of literature while identifying knowledge gaps regarding resiliency in waste created by disasters. Best approaches to improve waste infrastructure resiliency are assessed and grouped into four areas: reducing waste before a disaster occurs; using green infrastructure to curb the intensity of a disaster's effects; implementing a disaster waste management plan in the community; and using tools/models to help before, during, and after the disaster. Understanding how communities are applying resilient infrastructure will help other communities that may find themselves also responding to flooding, fires, tornadoes, and other natural events that may be exacerbated due to the impacts of climate change.

Disaster Decision-Making to Support Sustainable Waste Management

Marissa Matsler | U.S. Environmental Protection Agency

Disaster debris removal is essential for community recovery and resilience. However, it is a lengthy, costly, and logistically challenging part of response and recovery operations. Managing waste in a disaster situation requires the coordination of multiple entities at different levels of government, each acting under distinct authorities, all of which may vary with the type of incident (e.g., hurricane, animal disease outbreak). We present the results of social science research on decision-making about disaster debris removal. We discuss the social processes that underlie waste management decisions made at the federal, state, and local level before and after an incident. Sustainable options for waste disposal, such as recycling of electronics or metals, composting of vegetative debris or animal carcasses, and reuse of materials, are difficult to implement in disaster situations despite guidance and best intentions. Participants in this research outlined a number of obstacles they faced when making disposal choices. In our presentation, we describe the on-the-ground factors of disposal decision-making which include the influence of cost and reimbursement processes, non-disaster waste practices, and relationships. Finally, our presentation offers solutions grounded in social processes that can support more environmentally and socially sustainable disposal.

Assessment of Traditional Treatment and Disposal Methods for Biosolids Contaminated with *Bacillus globigii* Spores

Adam Burdsall | U.S. Environmental Protection Agency

Should biosolids be contaminated via an intentional malicious release or natural outbreak of *Bacillus anthracis* spores, a water resource recovery facility (WRRF) may need to consider if their treatment processes can sufficiently inactivate this pathogen. Three methods that are commonly employed to treat biosolids include lime stabilization, aerobic composting, and thermal incineration. They were investigated in the study in this paper through literature review followed by lab-scale experimentation. This research seeks to understand the conditions under which these traditional methods of pathogen treatment in wastewater biosolids may leave behind some surviving organisms that could cause the hazard to persist after treatment.

The literature component of this investigation was sufficient to indicate that lime stabilization may not be suitable to use with biosolids contaminated with *Bacillus anthracis* spores. The literature indicated that lime stabilization introduces calcium ions that the organism utilizes during sporulation, fortifying its protection and making the treatment counterproductive to the goal of spore inactivation. Therefore, the experimental component of this investigation focused on aerobic composting and incineration.

Although one 60°C control experiment inactivated *Bacillus globigii* to below detection limits, lab scale aerobic composting efforts had difficulties in achieving and maintaining the sufficient temperature throughout the composter to inactivate *Bacillus globigii* without also inactivating the organisms that perform aerobic composting. Over time, the composter's temperatures throughout decreased despite attempts to heat the



composter. A bench-scale fluidized bed incinerator was designed to mimic full-scale incinerators. Although conventionally assumed to be the most effective of the biosolids treatments, there were conditions under which incineration may leave viable organisms, particularly when the contaminated biosolids were fairly dry upon entering the incinerator.

The results from this investigation may help WRRFs to assess their facility's biosolids treatment methods and their ability to meet the needs for treating *Bacillus* contaminated material that enters their facility.

Efficacy of a Commercial Decontamination Product on Opioids, Adulterants, and Clandestine Laboratories

Evan Durnal | MRIGlobal

MRIGlobal evaluated the efficacy of a COTS decontamination product for efficacy against Fentanyl, Xylazine, and Methamphetamine. The product is established as a broad-spectrum decontaminant which shows good reactivity and efficacy against a variety of Chemical and Biological materials.

Target threats were chosen to provide data on current and emerging threats, as well as the long-standing issues associated with cleanup of clandestine methamphetamine production sites.

The product was evaluated against these drugs of abuse by MRIGlobal in a static reactor at a single application ratio of 1:10 target chemical to active decontaminant. The product showed activity against all target chemicals at the 1:10 ratio, reducing by 95% or greater in 5 minutes or less.

CONCURRENT SESSION 2 – BIOLOGICAL AGENTS: DECONTAMINATION

Logistically Viable Approaches for Wide Area Decontamination of *Bacillus anthracis* using Surrogate Spores

Ehsan Gazi | UK Defence Science and Technology Laboratory

The potential public health and economic consequences from the deliberate release of hazardous and persistent *Bacillus anthracis* (*B. anthracis*) spores into the urban environment are enormous. Beyond the immediate challenges of managing the consequences of such an event, technical options are required that can be deployed at scale to decontaminate affected urban areas.

The UK Government's Department for Environment, Food and Rural Affairs (Defra) is responsible for remediation following a homeland CBR event. Defra has partnered with Dstl to establish a National Technical Advisory Group for Recovery (NTAG-R), which is developing practical, low-volume ($\leq 300 \text{ mL/m}^2$) and scalable decontamination strategies by pulling-through state-of-the-art equipment and processes used in the agricultural industry.

We present on the sporicidal efficacy of pH adjusted peracetic acid (PAA) decontaminant, through a combination of track-sprayer experiments using agricultural equipment and dose-response data collected under controlled meteorological conditions. We determined the lowest dose (volume and concentration) of decontaminant needed to achieve target levels of hazard reduction on porous and non-porous surfaces, representative of urban materials.

A vehicle mounted sprayer system (VMSS), suitable in scale for operation on urban highways, was designed and manufactured with commercial-off-the-shelf components to deliver target doses onto spore contaminated surfaces. These full-scale system trials demonstrated that ground applications of $3.5 \pm 0.3 \text{ \% w/w PAA}$, using as low as 75 mL/m^2 , resulted in $7 \log_{10}$ reduction on non-porous steel surfaces; whereas, on porous brick surfaces higher applications of 143 mL/m^2 were required to achieve $\geq 5.5 \log_{10}$ reduction. Novel protocols were



developed to determine dose-response on vertically orientated surfaces, (while enabling surface run-off) using a further refined PAA decontaminant delivered in vertical spray mode by the VMSS.

Furthermore, we discuss technical risks such as using local water sources for decontaminant preparation and its impact on spray delivery, as well as the challenges in delivering a uniform initial target dose on vertical surfaces. Finally, we present containment level 3 suspension tests, which confirmed that the developed decontaminant can achieve at least the measured level of hazard reduction when applying the same treatment conditions to fully virulent *B. anthracis* spores.

Neutralization of Ricin Toxin on Building Interior Surfaces Using Liquid Decontaminants

Joseph Wood | U.S. Environmental Protection Agency

Ricin is a highly toxic protein, capable of inhibiting protein synthesis within cells, and is produced from the beans of the *Ricinus communis* (castor bean) plant. Numerous recent incidents involving ricin have occurred, many in the form of mailed letters resulting in both building and mail sorting facility contamination. The goal of this study was to assess the decontamination efficacy of several commercial off-the-shelf cleaners and decontaminants (solutions of sodium hypochlorite [bleach], a quaternary ammonium compound, sodium percarbonate, peracetic acid, and hydrogen peroxide) against a crude preparation of ricin toxin. The ricin was inoculated onto four common building materials (pine wood, drywall joint tape, countertop laminate, and industrial carpet), and the decontaminants were applied to the test coupons using a handheld sprayer. Decontamination efficacy was quantified using an in-vitro cytotoxicity assay to measure the quantity of bioactive ricin toxin extracted from test coupons as compared to the corresponding positive controls (not sprayed with decontaminant). Results showed that decontamination efficacy varied by decontaminant and substrate material, and that efficacy generally improved as the number of spray applications or contact time increased. The solutions of 0.45% peracetic acid and the 20,000-part per million sodium hypochlorite provided the overall best decontamination efficacy. The 0.45% peracetic acid solution achieved 97.8 to 99.8% reduction with a 30-min contact time.

Cu- and Ag-mediated Inactivation of *L. pneumophila* in Bench- and Pilot-scale Drinking Water Systems

Chelsea L. Hintz | U.S. Environmental Protection Agency

Legionella pneumophila (Lp) is an opportunistic drinking water pathogen that can cause infections through the inhalation of Lp-containing aerosols. Lp can occur in premise plumbing systems as these systems often have low disinfection residual, high surface area-to-volume ratios, water stagnation, and various water temperatures and velocities. These are all features that can lead to the colonization of Lp within plumbing systems. In this work the use of copper and silver ions was evaluated at the bench- and pilot-scale to determine 1) effective independent concentrations of copper and silver for inactivating Lp, 2) the impact of various water quality parameters on the effectiveness of copper and silver ions and 3) the effectiveness and practicality of using dissociation to produce ions at the pilot scale. At the bench-scale, it was determined that 0.3 ppm and 0.03 ppm of Cu and Ag, respectively, were effective at inactivating Lp in 5 hours in experimental buffer. But, in dechlorinated filter-sterilized tap water, the same concentrations of Cu were not effective, and the effectiveness of Ag was slower. pH and dissolved inorganic carbon content were found to be important parameters in determining if the use of Cu and Ag ions is appropriate. At the pilot-scale, dissociation was successfully used to produce Cu and Ag ions, but target levels of ions were difficult to achieve, and no impact was observed on Lp concentrations. Results from this study suggest that water chemistry in a plumbing system can impact the effectiveness of Lp disinfection using Cu and Ag.



Thermocatalytic Deactivation of Airborne Chemical and Biological Agents: Design of a Mobile Hot-zone Deactivation (MHD) System

Veera M. Boddu and Justin Morales | *U.S. Environmental Protection Agency*

One of the major focuses of the Homeland Security Research Program at EPA is to develop technologies and tools to address chemical and biological warfare agents (CBA) released accidentally or by terrorist actions. It is important that CBA contaminated air at high exposure settings (e.g., schools and office buildings) needs to be cleaned prior to the entrance of emergency response and cleanup crews. Airborne CBA, in general, are designed to be persistent in the air for long-time. Allowing the airborne CBA to settle would lead to diffusion of the agents into hard-to-reach creeps and crevices, porous surfaces, and HVAC systems.

A Mobile Hot-Zone Deactivation (MHD) system for destroying airborne chemical and biological threat agents was designed and fabricated at EPA's Research Triangle Park facilities. The MHD system draws airborne agent simulants through a high-temperature catalytic oxidation zone (steel-wool coated with titania or alumina catalyst powder). During future experiments, deactivated air will next enter a cooling zone where it cools the air to a reasonable exit temperature (80-100°F). The cooled air will then pass through a perlite filter to capture agent residue and by-products. The air will finally pass through a high efficiency particulate air (HEPA) filter to ensure all contaminants are captured before it is reintroduced into the surrounding area. The system is expected to provide sufficient residence time to transform the CBA into non-toxic and environmentally benign products. This research is in direct support of EPA's Office of Emergency Management's (OEM) preparedness for consequence management. The MHD system is designed to safely destroy/deactivate bacterial agents like spores of *Bacillus anthracis*, and toxins like ricin, and/or other airborne chemical agents Sarin and Sulfur Mustard (HD) and other agents including Toxic Industrial Chemicals and Toxic Industrial Materials (TICs/TIMs). This presentation includes the details of the design and fabrication of the MHD system and preliminary results of the deactivation airborne simulants.

CONCURRENT SESSION 2 - DECISION SUPPORT

Fast Estimation of CBR Contamination in the Urban Landscape, a Library Approach

Diego Mauricio Rojas Blanco | *Los Alamos National Laboratory*

Atmospheric dispersion of contaminants in the urban environment is a complex problem involving meteorology, turbulent transport, and agent-specific behavior (deposition, evaporation, photochemistry, etc.). Traditional Gaussian plume methods fail to capture the influence of buildings, a crucial aspect of the urban landscape. While physics-based approaches such as computational fluid dynamics (CFD) offer a high-fidelity solution to this problem, they're still far from being able to produce results in real time, let alone an ensemble of simulations. We propose an alternative approach for the fast visualization of simulated atmospheric CBR plume dispersion and deposition in the urban environment: a library of simulation results. This methodology essentially trades storage for preparation and compute time: having a set of pre-computed simulations with selected meteorological conditions and source locations for a given city. Our tool is based on the Quick Urban and Industrial Complex (QUIC), a software suite developed at LANL for the fast simulation of CBR plume dispersion in the urban environment. QUIC can provide a fast (in the order of minutes) solution of the plume, allowing for efficient construction of the simulation library. This approach allows authorities, who may only have approximate information of a CBR incident, to obtain a fast estimate of the extent of the outdoor plume and deposition; concentration and dosage, and deposition levels both outdoors and indoors. This information could be used for estimating evacuation/decontamination requirements in a matter of minutes during the initial stage of emergency response or could be used for training and exercises. The tool is set up such that non-experts can use the library and even set-up and run new cases. We'll show examples of our library approach to CBR incidents in several different cities and run the software in real-time if we are allowed to connect our own laptop.



Chemical Fires Module Phase II

Stephen Michael Davis | Battelle

The Hazard Prediction and Assessment Capability (HPAC) is used by the Defense Threat Reduction Agency (DTRA) Technical Reachback team to estimate an array of predictive chemical, biological, radiological and nuclear (CBRN) hazard scenarios. HPAC capabilities to assess the downwind hazards associated with the high-temperature decomposition of chemical species are limited. The DTRA Chemical Fires Module (CFM) was developed to enhance modeling of scenarios where toxic industrial chemicals/materials (TIC/TIM) are undergoing decomposition (via combustion or pyrolysis) as a result of fires.

The prototype CFM contained a database with two non-flammable chemical species (chlorine and bromine) and one flammable chemical (styrene) and was capable of modeling a variety of scenarios including fires contained within a structure or open to the atmosphere. The CFM now has an expanded capability to include representative chlorocarbons, sulfated hydrocarbons, organophosphates, hydrazine derivatives, and nitriles. Application of the CFM in a benchmark study of the Formosa Chemical Plant Explosion (2004) predicted downwind hazards from soot and hydrogen chloride comparable to the first-responder utilized evacuation distances. Additional improvements to the tool include updated air entrainment effects for outdoor fires, a prototype incident source model (ISM) for HPAC, and the development of a tool to assist analysts with database updates.

A Multi-Criteria Geographic Information System Screening Approach for Prioritizing Response Activities

Molly Rodgers | ERG

This presentation describes the development of a decision support tool, the Priority Response Environmental Screening Tool (PRESTO), designed to assist the U.S. Environmental Protection Agency (EPA), in partnership with state and local decision-makers, in prioritizing locations for initial cleanup operations aimed at reducing risks to public health and the environment after a natural disaster or chemical, biological, or radiological (CBR) incident. In the event of a natural disaster or release of CBR contaminants, for example, EPA and its partners would need to determine which locations should be prioritized to prevent the spread of contamination and mitigate long-term risks. Decision makers are often hampered by having too little or too much data, such that it is not obvious how relevant data can be incorporated into a decision-making framework. PRESTO provides a flexible and adaptable framework to address the challenges of aggregating data in a meaningful way to facilitate quickly identifying and understanding the resulting information to inform decisions. Results of a hypothetical analysis of a 10-mile radius study domain centered on Philadelphia, PA will be presented to demonstrate how PRESTO could inform disaster response planning following an incident. The presentation will illustrate how nine data sets measuring a range of issues reflecting risks to human health and the environment were used and show how substantial differences can exist in which locations would be prioritized for response depending upon which data aggregation scheme is applied.

Support for Decision-Making in Response to Environmental Emergencies: the GRADE Evidence-to-Decision Framework for Environmental & Occupational Health

Emily Senerth | Evidence Based Toxicology Collaboration

Background: Environmental health (EH) decision-makers are adopting systematized approaches for collecting and evaluating evidence about the health effects of exposures, yet there is no prevailing approach for integrating this evidence into decisions about site remediation, hazard mitigation, establishing safety standards, and other urgent and emergent scenarios. These decisions are often made in the context of low



certainty evidence and with far-reaching impacts on stakeholders, necessitating a standard and transparent process to ensure the credibility of recommended actions.

Objective: To introduce the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Evidence-to-Decision (EtD) framework for environmental and occupational health (EOH).

Methods: We conducted a two-step development effort beginning with a systematic review and narrative synthesis of published and public EH decision frameworks, followed by a modified Delphi process, engaging stakeholders from the following perspectives: risk assessment and management, nutrition and food safety, cancer, and socio-economic analysis. Identified decision-making criteria, including the existing GRADE EtD perspective for health system and public health decisions, were narratively synthesized.

Results: We combined 38 source frameworks and over 500 individual decision considerations with feedback from the Delphi panel (n = 20) to develop a consolidated and comprehensive decision framework, incorporating concepts from existing GRADE guidance, EH literature, and stakeholders. The EtD framework for EOH includes a scoping and contextualization process and twelve assessment criteria, which establish: the priority of the problem, desirable and undesirable effects of alternatives and the balance of these effects, certainty of the evidence, variability and uncertainty about values, resource implications, cost effectiveness, acceptability by stakeholder groups, and feasibility.

Conclusions: Policymakers, agencies, regulators, and other decision-makers may consider adopting the GRADE EtD for EOH to improve consistency and transparency in their approach to disaster mitigation, preparedness, response and recovery.

CONCURRENT SESSION 3 – BIOTHREAT CONTAGION PREPAREDNESS AND RESEARCH

Efficacy and Safety of Aerosolized Triethylene Glycol for Airborne Pathogen Inactivation in Indoor Spaces

Mitchel Simpler and Gediminas Mainelis | *JB&B and Rutgers University*

The COVID-19 pandemic has highlighted the importance of airborne transmission of infectious diseases, including those transmitted by humans. Infected individuals release respiratory droplets and aerosol particles when speaking, coughing, sneezing, or singing, with smaller aerosols ($< \sim 5\mu\text{m}$) remaining airborne for extended periods. Indoor spaces pose a higher risk due to airborne persistence, necessitating effective mitigation strategies. While masks, ventilation, and filtration help reduce airborne virus concentrations, there is a need for additional technologies to inactivate the virus in the air, where it poses the greatest threat.

Triethylene glycol (TEG), a substance with established germicidal properties, was identified as a potential solution. Aerosolized TEG demonstrated potent germicidal effects against respiratory pathogens, particularly when vapor molecules condense on particles containing microbes. Grignard Pure™, a product containing TEG, was developed to provide a safer way to aerosolize TEG for air treatment purposes.

This presentation will demonstrate the efficacy and potential application of Grignard Pure™ as an airborne antimicrobial agent. Laboratory experiments have demonstrated Grignard Pure™'s ability to effectively reduce airborne concentrations of MS2 bacteriophage, a surrogate for SARS-CoV-2 by 2-3 logs at GP aerosol concentrations of 0.04-0.5 mg/m³ (corresponding to TEG aerosol concentrations of 0.025 to 0.287 mg/m³). Multiple testing scenarios, including tests conducted by the US EPA, consistently showed significant reductions in viable airborne virus concentrations when using Grignard Pure™. Furthermore, when tested at the same aerosol concentrations against other microbes such as bacteria, mold, and TB, Grignard Pure™ demonstrated a 2-5 log reduction.

Additionally, comprehensive safety evaluations of TEG revealed its negligible toxicity when used as directed. Toxicological data showed minimal adverse effects in animal studies, and independent analyses confirmed TEG's safety for use at concentrations employed in Grignard Pure™. TEG has also been used in various commercial applications over the past 70 years at much higher concentrations without reported health issues. Considering the persistent threat of airborne pathogens, there's a pressing need for additional protective



measures. Aerosolized TEG, such as Grignard Pure™, offers a promising solution to quickly inactivate airborne pathogen particles.

Environmental Risk Assessment & Mitigation of COVID-19 and Other Pathogens: Field Sampling, Laboratory Analysis, and Assessment of Disinfecting Technologies

Judith Chui Ching Wong | *Singapore National Environment Agency*

SARS-CoV-2 virus is primarily spread through respiratory droplets, but also has the potential to spread via contact with contaminated surfaces and inhalation of aerosols. Here, we summarise efforts in environmental sampling and risk assessment of SARS-CoV-2 in various settings throughout the COVID-19 pandemic, as well as laboratory and field assessments on the efficacy of novel disinfecting technologies.

Environmental sampling of SARS-CoV-2 and Mpox was carried out to support case-investigations and to assess the risk of transmission via contaminated environments. Detection of SARS-CoV-2 RNA in air conditioner filter samples following a nosocomial outbreak of COVID-19 cases in a hospital ward suggested the likelihood of aerosol-based transmission. Further, the detection of SARS-CoV-2 RNA in air (37.8-66.7%) and fomite (7.3-28.6%) samples collected from various community premises, highlighted the need for good ventilation and regular cleaning, respectively, to minimize disease spread.

In addition to SARS-CoV-2, surveillance and risk assessment was also expanded to Mpox where live virus was isolated from samples collected from surfaces of the toilet seat, chair, and dust samples from linen used by a Mpox case. Mpox DNA was also detected in air samples (40.0-100%), surface swabs (36.8-94.7%), dust samples (100%), and toilet wastewater (0.0-100.0%) collected from the case's room, highlighting the need to focus on disinfection of high-risk surfaces and the need for respiratory protection.

To mitigate the risk of environmental transmission, particularly in prominent locations such as areas with high footfall or higher likelihood of transmission, technologies such as gaseous ozone disinfection and self-disinfecting surface coatings were evaluated in the field. Efficacy was assessed using a coronavirus surrogate (murine hepatitis virus) and gram-positive bacteria (*Staphylococcus aureus*). In field settings, 3.65- and 4.73-log reduction in virus and bacteria loads, respectively, were achieved for gaseous ozone disinfection of buses. In contrast, modest results were obtained in field trials of self-disinfecting surface coatings. Although disinfection efficacy ranged from 0.2-3.1-log reduction of virus load in laboratory trials, all products tested had no disinfection efficacy (0-0.1-log reduction) after two months in the field, suggesting limited product durability. Collectively, these findings have helped to guide public health response and inform disinfection protocols.

Efficacy of Chemical Disinfectants Against SARS-CoV-2 and Surrogate Coronaviruses on High-Touch Surface Materials

Megan W. Howard | *Battelle*

The EPA-approved disinfectant list features multiple products for use on high-touch surface materials, however the majority of these are registered for use only on non-porous materials. Many high-touch surfaces fall between non-porous and porous materials. The efficacy of four commercially available, EPA-approved chemical disinfectants (Clorox Total 360 (C360), Bleach solution, Vital Oxide and Peroxide) were assessed against SARS-CoV-2 and a surrogate coronavirus (MHV-A59) on stainless steel, latex-painted drywall tape, Styrene Butadiene rubber (rubber), and bus seat fabric. Testing evaluated spray (no touch with contact time) and spray and wipe (wipe immediately post-application) methods of cleaning either immediately (T0) or 2 hours (T2) after contamination with each virus and was evaluated via infectious virus recovery, with a subset tested for viral RNA (vRNA) recovery. Disinfectant efficacy varied by virus, method, disinfectant, and material. Bleach, C360 and Vital Oxide reduced surface MHV load by $>3\text{-log}_{10}$ for both Spray and Spray and Wipe methods. However, reduction of surface SARS-CoV-2 exhibited differential efficacy between Spray only and Spray and Wipe methods, with the Spray and Wipe method showing an increase in log reduction for most disinfectants and materials tested. Differential efficacy was also observed between virus species. While limited differences were observed between MHV-A59 and SARS-CoV-2 for C360, significant differences were observed with



bleach solution. In particular, bleach application via the Spray only method resulted in far greater efficacy against MHV-A59 than SARS-CoV-2, but resulted in nearly equal efficacy when the Spray and Wipe method was used. Interestingly, when vRNA and infectious virus recovery of SARS-CoV-2 were compared, disinfectant treatment biased vRNA recovery over infectious virus recovery; PCR also yielded positive detection when no infectious virus was detected by culture. These results suggest that RT-PCR monitoring post-disinfection could inflate the estimates of potential risk post-disinfection, and careful consideration of surveillance approaches relying solely on RT-PCR for coronaviruses should take care in reporting their outcomes. Our results suggest that disinfection efficacy is material-, method-, and disinfectant-specific, and method and surrogate choice is critical for determining disinfectant efficacy for emerging threat agents.

Disinfection of Sensitive Device Surfaces Contaminated with COVID-19 Surrogates and Role of Organic Burden

Vipin Rastogi | *U.S. Environmental Protection Agency*

Household and workplace surface disinfection of respiratory viruses commonly uses disinfectants prepared as aqueous solutions. Aqueous-based solutions are unsuitable for sensitive surfaces, such as computers, laptops, and mobile devices. Ultraviolet Germicidal Irradiation (UVGI) ultraviolet is a non-invasive approach for sensitive device surfaces. Phase 1 of this study evaluated the efficacy of viral disinfection of three commercial devices, i.e., LumiCleanse Portable Tower, Cretors UV Sterilization Chamber, and a hand-held wand on keyboard plastic, aluminum, tempered glass, and chair fabric surfaces. The two most promising of the effective UVC sources, the chamber and tower were transitioned to Phase 2 of the testing. In this phase, a cell phone, laptop screen and touchpad, and computer mouse were the test surfaces. This study included two COVID-19 viral surrogates, i.e., Phi-6 and HuCoV-229E. Approximately 4-6 logs of viral load were challenged on test surfaces. In Phase 2, the role of three organic bioburdens, 5% fetal bovine serum (FBS), synthetic sputum, and simulated saliva was investigated using aluminum as the test surface. Efficacy results from both Phases will be summarized and presented in this briefing. Overall, the results show effective disinfection of HuCoV-229E (75-150 mWatts/sq-cm for >3-log reduction) on tested surfaces by UVGI except for the fabric (requiring >2000 mWatts/sq-cm for 1-2 log reduction). The results differed significantly with Phi6, depending on the test surface. A range of 216-6000 mWatts/sq-cm was needed for three of the test surfaces to achieve a 3-log reduction, and almost 7000 mWatts/sq-cm was required for a 1-log reduction with fabric. Interestingly, the inclusion of bioburden with simulated saliva or FBS with both test surrogates did not appear to affect the disinfection efficacy of UVGI. However, including synthetic sputum significantly reduced the effectiveness of UVGI against both test surrogates. Shadowing, presence of interfering materials such as dust/dirt on surfaces and on light sources are important considerations before applicability of UVGI as an effective sensitive device disinfection approach in real-life scenario.

CONCURRENT SESSION 3 – APPLICATIONS OF SOCIAL SCIENCE – DECON, SAMPLING AND RISK COMMUNICATION

Environmental Justice Organizing Around Chronic Environmental Contamination

E. Christian Wells | *University of South Florida*

While there are a growing number of success stories of communities with environmental justice challenges achieving procedural, distributive, or even restorative justice, what happens in situations of chronic environmental contamination where hazardous substances persist for prolonged or undetermined periods, or where decontamination and remediation are impossible? In these cases, environmental justice organizing expands to include coping with contamination and creating strategies for resilience. In this paper, I use a case study approach to examine the racially segregated community of Tallevast in the central Gulf Coast of Florida, where our research team has been working with a community-based nonprofit to advocate for environmental justice in the wake of groundwater contamination caused by the American Beryllium Company and its



subsidiaries since the 1960s. Oral histories documented from community residents indicate that their environmental justice organizing has evolved to include not just the human and environmental health impacts of the contamination and efforts to decontaminate soil and groundwater, but also the social, political, and economic determinants of health and persistence in the community.

Minimizing Infectious Disease Outrage with Communication and Behavioral Intervention Strategies

Sean G. Kaufman | *Safer Behaviors*

Infectious diseases challenge every basic human need. They can contaminate food, air, and water; cause fear for both the body and within the mind; kill or separate us from our family and friends; and make us reliant upon others for our own health and safety - challenging our self-esteem and value.

Risk Communication Challenges with PFAS Contamination of Drinking Water

Matthew W. Seeger | *Wayne State University*

Risk communication is a well-developed field of research and practice (Renn, 2020; Balog-Way, McComas, & Besley, 2020). Risk communication is “the systematic dissemination of information to diverse audiences (e.g., individuals, communities, and institutions) facilitating their informed, independent decision making about the existence, nature, and/or severity of risks and hazards affecting health, safety, and the environment,” (DiClemente & Jackson, 2016, p. 378). The goal of risk communication is to help all affected parties to make informed choices about matters of concern to them (Renn, 2020).

Per- and Polyfluorinated Substances (PFAS) are a class of compounds that have recently identified as drinking water contaminants. The EPA PFAS Action Plan (2020) notes that “Risk communication and engagement are critical for EPA to effectively support communities across the United States that are addressing PFAS” (p. 16). Effective risk communication and community engagement around issues of PFAS contamination has created a number of challenges (Ducatman et al., 2022). Much of the official communication about PFAS, however, has not tailored to specific audience needs and community conditions nor has it effectively addressed the challenges surrounding emerging yet ubiquitous contaminants.

The presentation summarizes current research on risk communication and the limited research on communicating PFAS risk to affected parties. Based on experiences with the State of Michigan with PFAS contamination, the communication ecosystem for PFAS communication is described and specific communication challenges are identified including high uncertainty about the impact of PFAS, sources of contamination and mitigation strategies, misleading information, and low levels of trust among the public. The effectiveness of risk PFAS risk communication requires understanding community risk perception through direct engagement with impacted stakeholders (Harclerode, et al, 2021). Maintaining openness, honesty and transparency is challenging when contamination sources are unclear and is related to the development of trust and credibility. The frequency of communication and message consistency when multiple agencies and organizations are involved are also important (Seeger, 2006).

This presentation concludes by offering a set of best practices for addressing the challenges of PFAS communication.

Applying Risk Communication Best Practices During Emergency Response

Madeline Beal | *U.S. Environmental Protection Agency*

This presentation will highlight the best practices in risk & crisis communication literature, including models and theories, that can be applied to respond to environmental disasters and emergencies. The session will include audience interaction and engagement through practice scenarios.



PLENARY SESSION

Doing Disasters Differently: Diversity, Equity and Inclusion in Emergency Management

Marcus Martin, COO | *Institute for Diversity and Inclusion in Emergency Management*

Abstract not available.

Plenary Talk: Doing Disasters Differently: Diversity, Equity and Inclusion in Emergency Management

Bill Steuteville, Region 3 Homeland Security Coordinator | *U.S. Environmental Protection Agency*

The *Draft Wide-Area Radiological Disaster Cleanup Strategy* are EPA's recommendations for cleanup following a radiological disaster pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the National Response Framework (NRF), and the Nuclear/Radiological Incident Annex (NRIA). Under the NRF and NRIA, EPA is responsible for pre-disaster preparedness and planning and for leading post-disaster Federal support for radiological mitigation and cleanup. The draft Strategy is a product of EPA's National Radiation Preparedness Group. The Strategy is a comprehensive approach to all aspects of planning and managing radiological cleanup. This presentation will focus on the cleanup technologies, testing, methods, and protocols necessary for timely, efficient, cost-effective wide-area radiological cleanup.

POSTER SESSION

1

(Student)

Method Development Biological Agent Personal Decontamination Effectiveness for Airman Battle Uniform Fabric Material: MS2 Bacteriophage

Alisha Helm | *Air Force Institute of Technology*

This study investigated the effectiveness of a common decontamination (decon) strategy used by Airmen in the United States Air Force who may find themselves in a densely populated area during an emergency evacuation (evac). Specifically, this study focused on assessing the concentration of viral particles that become re-aerosolized from uniform fabric after a common decon procedure is applied. Lastly, the study addressed the following questions: Is there a significant difference in the number of viral particles being aerosolized before and after the applied decon strategy, and is this difference significant enough to consider the decon strategy effective? The experimental setup of the study involved using the surrogate bacteriophage *Emesvirus zinderi* (Enterobacteria Phage Male Specific 2 picornavirus, group 1 RNA-phage or MS2) to contaminate swatches of Airman Battle Uniform (ABU) fabric. Swatches were secured to a vortex centered in the middle of a mini aerosol chamber. Then, MS2 was aerosolized at a 10^{10} plaque-forming units per milliliter (PFU/mL) concentration using a six-jet Collison nebulizer to contaminate swatches. Next, the decontamination procedure was applied, and air sampling occurred using the SKC BioSampler with sterile deionized water as the collection liquid. MS2 particles were re-aerosolized from the ABU fabric by vibration at a 50 Hz frequency using a Vortex. Plaque assay analyses were conducted to determine overall aerosol concentrations post-decontamination (wet fabric re-aerosolization "WFRA") and pre-decontamination (dry fabric re-aerosolization-DFRA). The null hypothesis, suggesting that there will be no statistical significance between the WFRA and DFRA was rejected with a Student's T-Test p-value of 0.001. Results showed less than a $1 \log_{10}$ reduction in PFU/mL for re-aerosolized MS2 after the decontamination procedure was applied.



2

Decontamination of Vegetation to Inactive *Bacillus anthracis* Surrogate Spores and Assessment of Decontaminant Damage to Plants

Joseph Wood | U.S. Environmental Protection Agency

The Analysis for Coastal Operational Resiliency (AnCOR) program is an interagency collaboration between the U.S. Environmental Protection Agency (EPA), the Department of Homeland Security (DHS), and the United States Coast Guard (USCG). The overall purpose of this multiagency program is to develop and demonstrate capabilities and strategic guidelines to prepare the U.S. for a wide-area release of a biological agent, including mitigating effects on USCG facilities and assets. Following a wide-area release of *B. anthracis* spores, vegetation may become contaminated with the biological agent. Decontamination of vegetative materials such as trees, grass, and crops, especially on a large scale, will be a challenge, due to the organic nature of vegetative materials, and the potentially large and complicated surface areas of foliage. Other challenges include effectively decontaminating the plants without killing or damaging them. The study described in this poster presentation was conducted under the AnCOR program, with the goal of assessing efficacy of decontamination options for vegetative materials contaminated with *B. anthracis* spores. For the decontaminants that were determined to be efficacious, subsequent tests were conducted to determine if any damage to plants occurred over a month after spraying them. Tests were conducted at bench and pilot scale, using a variety of small plants including evergreens, deciduous plants, ground cover, sod/grass, and pine tree bark. Efficacy tests were conducted using *B. atrophaeus*, a commonly used surrogate for *B. anthracis* decontamination studies. Other test variables included the use of several decontaminants and active ingredient concentrations. Initial tests showed that inoculation and recovery of spores from plant materials did not present any difficulties. Efficacy results showed that peracetic acid (PAA) was generally the most effective decontaminant for vegetative materials, followed by dichlor. (PAA was evaluated since some commercial off-the-shelf pesticides used for plants and crops have PAA as their active ingredient.) Pine bark was the most difficult material to effectively decontaminate. Simple phytotoxicity tests were conducted to assess any detrimental impacts of the decontaminants, such as leaf discoloration, leaf loss, and lack of growth. While no plants died during the month-long observations following exposure to the decontaminants, there were some mixed results with respect to other phytotoxic effects.

3

Study of Historical BOMARC Non-Critical Weapon Accident Debris

Gaiven Varshney | Air Force Institute of Technology

Investigation of nuclear materials and debris collected from nuclear accidents is considered crucial in identifying the source, purpose, origin, and formation history of the material. In this work, non-destructive analysis (NDA) were employed to identify, isolate, and characterize actinide bearing particles from bulk soil samples collected from a historic BOMARC Accident Site.

4

Evaluation of Clear Topcoats to Alter Chemical Resistivity of Polyurethane Coated Military Assets

Janlyn Hope Eikenberg | U.S. Army

Military polyurethane-based coatings are designed to support multiple requirements, including corrosion control, signature management, and agent resistance. The ability to increase the agent resistivity of these polyurethane-based coatings without significantly altering the other required characteristics is greatly desired by the Department of Defense. A clear topcoat that can be applied over the polyurethane-based coating to increase the overall agent resistivity could allow for the reduction in Mission Oriented Protective Posture (MOPP) for the warfighters, and also reduce the logistical burden of hazard mitigation efforts.

Vendors from across academia, industry, and U.S. government laboratories supplied over 50 clear topcoat candidates for evaluation of agent resistivity and other characteristics. The topcoat candidates cover a wide range of chemistries including omniphobic and anti-corrosion technologies, which may improve the agent resistance of the top coated asset. Topcoat candidates were also evaluated for gloss and IR reflectance.



These evaluations were conducted on both pristine test substrates and on test substrates subjected to 6 months of natural outdoor weathering in Florida.

Initial testing was conducted using three colors (black, green, and tan) of control polyurethane-based coating and three chemical agents. Results in agent resistance for the topcoat candidates ranged from worse than the control coatings, to the better performing topcoats retaining >50 times less agent than the control coatings.

In addition to the lab-scale testing, two topcoat candidates were evaluated on full-scale military assets in a field setting using methyl salicylate as a surrogate. Both topcoat candidates performed well, significantly reducing the downwind vapor hazard to warfighters.

The best candidates from the initial testing were selected for further resistance and weathering studies. Initial results from these down selected studies will be shared in the presentation.

Experimental details, results and path forward will be provided in the presentation.

5

Adsorption of Perfluoroalkyl Substances with Activated Carbon: Characterizing Non-Hazardous Simulants

Jennifer Hensley | *Air Force Institute of Technology*

This work investigated the suitability of three non-hazardous food dyes as PFAS simulants during wastewater treatment with powdered activated carbon (PAC). Batch experiments with PAC were conducted to determine equilibrium constants (Log Kd) and pseudo first-order adsorption rate constants (k) for allura red, tartrazine, indigo carmine, PFOA, PFOS, and several other PFAS species commonly found in aqueous film-forming foam. The food dyes were found to have k values comparable to PFOA, PFOS, and other PFAS species. An Artificial Neural Network (ANN) was developed to predict the surrogacy of the food dyes by correlating sixteen molecular descriptors with publicly-available Log Kd values. Based on experimental observations and ANN predictions, all three food dyes were found to be conservative simulants for PFBA, PFBS, and PFHpA (i.e., food dyes Log Kd > PFAS Log Kd), but poor simulants for PFOA, PFOS, and other PFAS species (i.e., food dyes Log Kd < PFAS Log Kd). The PAC was analyzed using Scanning Electron Microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS) to reveal fluorine and PFAS functional groups attached to the surface. These results are expected to inform future efforts to identify non-hazardous simulants that could be tested in place of toxic PFAS species.

6

Cleaning of Personal Protective Equipment and Laundry Contaminated by Viruses

Anne Mikelonis | *U.S. Environmental Protection Agency*

The COVID-19 pandemic illuminated gaps in viral disinfection data for personal protective equipment and materials typically laundered at home. In support of responders, decision makers, and the general public's questions concerning the use of different cleaning methods, the United States Environmental Protection Agency's (U.S. EPA) Homeland Security Research Program launched research to generate data testing different disinfectants and cleaning methods' efficacy at reducing the load of the bacteriophages Phi6 and MS2 from different materials. To-date five different disinfectants/cleaning methods have been tested: bleach spray, isopropyl alcohol wipes, laundering (washing and drying), low concentration hydrogen peroxide vapor, and a quarternary amonium spray. These disinfectants/cleaning methods have been tested on face coverings, procedural masks, scrubs, denim, safety glass, face shields, shoes, and N95 respirators for materially compatible combinations. This poster will summarize the work "Evaluation of disinfection methods for personal protective equipment (PPE) items for reuse during a pandemic" (<https://doi.org/10.1371/journal.pone.0287664>) and the method "Determining Viral Disinfection Efficacy of Hot



Water Laundering” (<https://doi.org/10.3791/64164>). It will also provide additional photographs beyond those provided in the manuscripts and discuss ongoing research pertaining to additional laundering processes.

7

(Student)

Maximizing SARS-CoV-2 RNA Output from Wastewater Samples: An Evaluation of Extraction Principles for Increased Viral RNA Recovery

Nita Khanal | *University of North Carolina at Charlotte*

The detection of SARS-CoV-2 in wastewater provides a cost-effective alternative over expensive approaches such as random testing of groups and individual clinical tests and has the potential to detect asymptomatic cases. One widely used Virus concentration method for large-volume wastewater is ‘Electronegative Membrane Filtration (EMF)’, which is an easily available and cost-effective tool for detecting and quantifying the presence of the virus in wastewater samples. However, there is a lack of research on the use of efficient RNA extraction methods in conjunction with the ‘EMF’ method. This study aimed to achieve efficient, optimized, and cost-effective RNA extraction kits for wastewater surveillance by combining them with the EMF Method of Virus Concentration. To complete this, raw wastewater samples were collected from three wastewater treatment plants in Mecklenburg County. Two RNA extraction protocols, the ‘QIAamp Viral RNA Mini Kit’ and the ‘Zymo Quick RNA viral Kit’, which used Lysis buffer principles, were modified to improve RNA yield using the entire volume of filtered samples. This was done by changing the buffer ratios and the inhibition removal process. These two optimized methods were then compared with two other extraction methods, the ‘RNeasy power water kits’, and the ‘All prep power viral DNA/RNA kit’. These use a different principle called bead-beating and recommend using the whole volume of filtered samples. The Zymo Quick RNA viral kit was found to have significantly better performance than the other three kits in terms of Cq value (29-31), Copies per reaction, and Copies per liter (100,000 to 350,000, $P < 0.01$). That also showed a better recovery of 10% of the surrogate Bovine CoronaVirus (BCoV). However, there was no significant difference observed between the All prep power viral DNA/RNA kit and the Viral RNA Mini Kit ($P > 0.05$). Moreover, ‘Zymo kit’ was found to be cost-effective at \$159.5 for 50 preps as compared to other extraction methods (\$469 for QIAamp Viral RNA Mini Kit, \$551 for All prep DNA/RNA kit, and \$710 per RNeasy Power water kit). This suggests that the ‘Zymo Quick RNA viral kit’ is more efficient at extracting and purifying viral RNA, leading to more accurate quantification of the virus and informing public health decision-making. Additionally, it can result in more sensitive and specific diagnostic tests, which is crucial for early detection and control of the virus.

8

Decontamination of Home Plumbing Pipes Contaminated with Per- and Polyfluoroalkyl Substances (PFAS) from Aqueous Film Forming Foams (AFFF)

Jeffery Szabo | *U.S. Environmental Protection Agency*

Home plumbing can be contaminated with PFAS from aqueous film forming foams (AFFF) through accidental backflow resulting from firefighting related activities, including back-siphoning during routine maintenance of equipment. This exact incident did occur in Wyoming, OH in 2018, Neville Island, PA in 2019 and Westmoreland County, PA in 2020. As of now, no known, intentional studies of PFAS persistence on any home plumbing materials have been performed.

In order to determine if PFAS persists on home plumbing materials, a pilot scale setup containing copper, polyvinyl chloride (PVC), and cross-linked polyethylene (PEX) pipes was built. Three pipes of each material were installed so that triplicate experiments could be conducted simultaneously. Pipes are 1-inch diameter, 55 inches long and are supplied with local tap water. Flow through each pipe is regulated with a solenoid valve that opens on the hour between 7:00 am and 4:00 pm for 10 min and allows flow at 2 gpm. This demand pattern results in 200 gallons flowing through each pipe each day, with stagnation between the openings and overnight. Pipes were conditioned using this flow pattern for four months.

Two separate experiments were conducted with pipes replaced in between and conditioning restarted. In the first experiment, the pipes were contaminated with a 3% solution of 3M Lightwater AFFF, which is an older formulation containing PFOS and PFOA. In the second experiment, Phos-chek was used, which is a new formulation without PFOS or PFOA. After the contamination period (4hrs), the pipes were flushed for 20



minutes at 4 gpm. After flushing, the normal daily demand pattern was reestablished for two days, with one additional four-day period of stagnation thereafter. Samples were taken before and after stagnation periods to determine if the initial flushing is enough to remove any adhered PFAS, or if it releases from the pipes after stagnation.

Data produced from this research showed that while over 99% of the PFAS was removed via flushing, levels above existing health advisories remained for some PFAS compounds. More importantly, PFAS adhered to pipe walls could re-emerge in the water phase after stagnation at concentrations higher than immediately after flushing. This is important to consider when designing a sampling strategy to ensure that PFAS is adequately flushed from plumbing pipes.

9

(Student)

Production of Acids and Bases for CO₂ Sequestration Using Bismuth/Nickel Hexacyanoferrate Desalination Battery

Princess Merenini | *University of Wisconsin at Madison*

Capturing CO₂ from the atmosphere is essential to combat the issue of climate change. Most CO₂ capture technologies utilize the difference in solubility of CO₂ in acidic or basic solutions. Typically, inorganic acids and bases are used to induce pH swings and enhance CO₂ solubility, but this approach introduces unwanted cations and anions, necessitating additional purification steps. Emerging electrochemical strategies are an alternative route to producing pH swings in situ without adding inorganic chemicals. Despite the advantages of electrochemical methods in reducing the need for upstream purification, their widespread practical adoption has been hindered by the production of gaseous byproducts, high energy consumption, and costly catalysts. This study presents an innovative approach involving an energy-efficient and low-cost desalination battery capable of generating the required pH swing for CO₂ capture from saline water (0.6M NaCl). In this presentation, I will discuss my work developing electrochemical processes that utilizes Bi and Nickel Hexacyanoferrate electrodes to generate NaOH and HCl at 40% lower energy consumption than conventional electrochemical systems like Electrodialysis with Bipolar Membrane (EDBM).

10

Using Community Case Studies to Test the Equitable Resilience Builder

Brittany Kiessling | *U.S. Environmental Protection Agency*

The U.S. Environmental Protection Agency's newly released tool, the Equitable Resilience Builder (ERB), guides practitioners through a resilience planning process that provides support for communities in the face of climate change and disasters. The ERB process is specifically designed to address a wide range of disaster types, including contamination incidents, and is customizable depending on a community's priorities. The ERB includes information and activities to help planners form a team, engage their community, assess local resilience indicators, prioritize actions, and get started with solutions. The content of the tool was developed through extensive iteration and input from potential end-users, helping to fine-tune its usability. This iteration involved three community case studies, taking place in Grand Rapids, Michigan, Buffalo, New York, and Augusta, GA/Aiken, SC. This poster details the process and outcomes of each of these case studies. Specifically, the poster highlights key findings such as the importance of local partnerships and trusted facilitators in the implementation of resilience planning, as well as the need for a trauma-informed approach to engagement. The poster offers lessons learned that may be applicable to other tool development, especially tools and resources related to incident response, disaster recovery, and preparedness.

11

Mpox Virus DNA Contamination Can Still be Detected by qPCR Analysis After Autoclaving

Sean Collins | *UK Health Security Agency*

Introduction: During the outbreak of mpox in 2022, environmental sampling took place in multiple hospitals and outpatient with the purpose being to validate the effectiveness of infection



prevention and control (IPC) measures and identify possible transmission routes when caring for infected patients. This investigation was carried out to determine how MPXV DNA was detected in “clean” areas.

Methods: Two hospital clogs (A and B) were surface disinfected and divided into 4 quadrants, each inoculated with MPXV DNA and left to dry. Each quadrant was swabbed using a COPAN UTM Swab. Two sampling methods were used: Clog A was sampled by swabbing a different quadrant sequentially prior to autoclaving and after each of the three autoclave cycles; Clog B involved repeat sampling of all four quadrants before autoclaving and then after each autoclave cycle. Three autoclaves were performed. All samples were inactivated, DNA was extracted and analysed by qPCR.

Results: A total of 20 samples were taken, 4 from Clog A and 16 from Clog B. All samples taken from both clogs had detectable amounts of viral DNA, albeit with a reduction of ~1000-fold ($3 \log_{10}$). The decrease in DNA detected was consistent in samples taken pre-autoclave and after the first and second autoclave cycles. After the second autoclave cycle, the Ct values plateaued on both clogs.

Conclusion: Although autoclaving reduced the quantity of viral DNA recovered from the clog surfaces, it did not degrade it completely and viral DNA was still detected by qPCR on surfaces, albeit at levels close to the limit of detection. The data from this study shows that MPXV DNA can still be detected by qPCR after multiple autoclave cycles and reuse of previously contaminated autoclaved PPE might result in deposition of autoclaved, non-infectious nucleic acid in other environments.

12

Wind Flow Characterizations Within Uniform and Non-Uniform Building Configurations Using Wind Tunnel Data and Large Eddy Simulations

Michael Pirhalla | *U.S. Environmental Protection Agency*

Dispersion models, which are important tools for efficient routine releases and emergency response preparation scenarios, typically incorporate logarithmic wind speed profiles when simulating flow and downwind dispersion. This may be acceptable for regions with low surface roughness and minimal obstructions. However, within urban (or suburban) canopies, vertical wind speed and turbulence profiles may be altered due to wake turbulence and channeling flows generated by the presence of buildings and other structures. The added drag tends to slow the wind speed within the canopy and develop an inflection point at or above the mean building height. These situations can affect the prediction of downwind dispersion and plume concentration and behavior, which may not be accounted for in some traditional modelling exercises. This project leverages data from a series of large-eddy simulations (LES) and EPA meteorological wind tunnel experiments that use two 1:200 scale models designed to represent a residential neighborhood with avenues and rows of two-story rectangular houses. Two building configurations are compared: one with uniform rows of buildings with heights of 12 m full-scale, and a second with an alternating array of variably sized, non-uniform buildings with heights ranging from 12-20 m. The LES model results enable fine-scale comparisons with Laser Doppler Velocimetry (LDV) and Particle Image Velocimetry (PIV) data gathered in the wind tunnel. The LES also permits us to simulate a variety of additional oblique incident wind directions (from 0-50 degrees). The goal of this project is to compare the wind tunnel and LES datasets to inform improved urban wind speed and turbulence profiles (and potential parameterizations) in Gaussian dispersion models, which may inform emergency response scenarios following a harmful release in a populated area. Preliminary results show that wind tunnel datasets compare very well with the LES and accurately capture regions of high wind shear at the tops of buildings, including profiles measured within intersections and in areas bounded by buildings. The LES suggest the consideration of dispersive stresses (in addition to turbulent stresses) when developing future characterizations in dispersion models, especially for non-uniform building scenarios.

13

Research to Inform Decontamination Strategies for Fentanyl-Contaminated Sites

Lukas Oudejans | *U.S. Environmental Protection Agency*

Illicit fentanyl activities can lead to complex contamination incidents and create exposure risks to law enforcement, emergency responders, remediation contractors, and the public. The objective of this presentation is to provide an overview of conducted research to assist in technical support requests



from local and state entities to US Environmental Protection Agency (EPA) related to fentanyl responses across the country. It will contain results from research that was initiated to fill select gaps identified during the development of EPA's Fact Sheet for On-Scene Coordinators: Fentanyl and Fentanyl Analogues. Decontamination operations will benefit from in situ degradation options for fentanyl and its analogues on building materials. Current remediation knowledge is limited to the core chemistries of several oxidizers such as hydrogen peroxide, peracetic acid or hypochlorite (bleach). EPA research efforts produced data on the efficacy of several decontamination options for building materials as well as protective gear/PPE. These data include results from bench-scale decontamination tests using nonporous contaminated surface materials and decontaminants that were applied by spray application under real-world conditions. This poster will provide best practices for emergency managers on how to efficiently sample fentanyl-contaminated surfaces and how to clean/decontaminate them effectively.

14

Biological Decon: Point-of-Use System for Non-Liquid Treatment of Solid Material

Jon Calomiris | *Sotiria Science*

BACKGROUND: On-site decontamination of solid materials can pose operational challenges. Systems employing vaporized hydrogen peroxide, chlorine dioxide, or ethylene oxide require complex equipment, operator training, and electric power. In this study, a simple treatment chamber was developed for controlled passive generation of Cl_2 from a small volume of dilute hypochlorite amended with acetic acid. Proof of concept as effective disinfection was demonstrated with face masks as solid test material. **METHODS:** Treatment effectiveness was assessed with N95 mask (NIOSH approved) filter medium amended with dormant *Bacillus thuringiensis* subsp. *kurstaki* spores as disinfectant-recalcitrant microbes. Treatment was also assessed with surgical masks worn by healthcare workers. The treatment chamber (5.7-L plastic container) housed test materials (swatches and masks) and disinfectant source (dilute Clorox® disinfectant bleach amended with distilled vinegar, 10-ml total volume) for passive generation of Cl_2 into the airspace. Various concentrations of disinfectant and acid were tested to determine optimal conditions for controlled Cl_2 generation. Following treatment at 20°C, microorganisms were recovered from test materials with elution buffer (nonionic detergent and polyanionic compounds) and enumerated by the membrane filtration method with nutrient agar. Chamber Cl_2 concentrations were derived from remaining chlorine levels of the disinfectant source measured with DPD (N,N'-diethyl-p-phenylenediamine). **RESULTS:** Kinetics of Cl_2 release into the chamber airspace was a function of the hypochlorite-to-acid ratio of the source disinfectant. Cl_2 diffused effectively throughout the chamber and through the layers of N95 filter medium. At least a 5-log reduction of viable spores on N95 swatches was demonstrated following treatment with approx. 2 mg/L Cl_2 at 20°C for 2 hours. No cultivable microbes were recovered from used surgical masks following treatment. **CONCLUSIONS:** Findings of this study provide the basis for low-burden, low-cost protocols for point-of-use disinfection of solid items. Potential system applications include (1) material reuse, (2) biohazard decontamination for safe handling, storage, transport, and disposal, and (3) field operation at sites lacking electric power and other resources. Based on substantial inactivation of spores, the system offers potential for effective treatment of items contaminated with viral, bacterial, and fungal pathogens.

15

Impacts of a Surface Washing Agent and Chemical Herder on the Aerobic Biodegradation of Crude Oil

Kiara Lech | *U.S. Environmental Protection Agency*

Dispersants, surface washing agents, and chemical herders expand the range of response options available to decision-makers during oil spills. Due to the reliance on chemical dispersants during the Deepwater Horizon oil spill, impacts of dispersants on oil biodegradation have been heavily investigated and scrutinized. Less is known about the fate of other chemical treating agents and effects on marine microbial communities, including those responsible for oil biodegradation. Using an oil-degrading microbial consortium, we examined the impacts of a surface washing agent (CytoSol) and chemical herder (ThickSlick 6535) on the aerobic biodegradation of oil in laboratory incubations. We measured the transformation and mineralization of



weathered crude oil and spill treating agents, changes in microbial biomass, and alterations of microbial community structure over 48 days.

The degradation of parent hydrocarbon compounds was minimally impacted by the introduction of CytoSol and ThickSlick 6535. Microbial growth was enhanced by the addition of the chemical treating agents and distinct shifts in the microbial community were observed among treatments and over the duration of the study. Mineralization occurred in all treatments including those containing treating agent alone (i.e., no oil or other carbon), signifying the oil-degrading microbial community can also readily degrade CytoSol and ThickSlick 6535. Higher levels of carbon dioxide were produced in treatments containing both oil and treating agent than the sum of the individual treatments. These laboratory findings suggest that these chemical treating agents pose little risk to oil-degrading microbial communities in-situ and potentially enrich for specific microbial groups that promote complete biodegradation.

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Validation of Large-Space Decontamination via Fogging: Improved Sampling Methods for Virucidal Efficacy Testing

Jessica Mason | U.S. Department of Homeland Security

Aging biocontainment laboratories often require complex and multi-faceted approaches to achieve effective decontamination of large laboratory and vivarium spaces. In support of the development of validated protocols for terminal facility decontamination and decommissioning of the Plum Island Animal Disease Center (PIADC), the SteraMist Environment System, an ionized hydrogen peroxide (iHP) fogging system, was evaluated for its ability to inactivate the small non-enveloped ssRNA Foot-and-mouth-disease virus (FMDV), and the large nucleocytoplasmic DNA African swine fever virus (ASFV) dried on representative laboratory surfaces. Tests were conducted in a ~13,000 ft³ BSL3-Ag vivarium room typically used to house cattle. FMDV and ASFV virus stocks were mixed with a standardized soil load and dried on 1 cm non-porous stainless-steel disks and 1 cm³ porous concrete testing coupons. Stainless steel ribbons containing 6 logs *Geobacillus stearothermophilus* (GST) spores as biological indicators (BIs), and hydrogen peroxide (H₂O₂) chemical indicator strips (CIs), and viruses were magnetically affixed at 36 sampling sites throughout the room. SteraMist Binary Ionization Technology® Solution (7.8% H₂O₂) was fogged at a dose of 0.5mL per ft³ through two Environment Systems and allowed to dwell for a total of 15 minutes followed by a 2-hour room aeration period prior to sample collection. Results demonstrated efficient coverage of iHP throughout the room in, as evidenced by 100% positivity of CIs, and 100% negativity of all GST BIs. FMDV and ASFV were completely inactivated on stainless steel after a 15-minute iHP dwell time in 72/72 samples (n=36/test) (FMDV >5.5LR; ASFV >4.3LR). Additionally, ASFV was completely inactivated on concrete (72/72 negative). Inactivation of FMDV on concrete proved to be more difficult, with initial titrations resulting in very low, but detectable, positivity rates (1/36 positive in Test 1; 5/36 positive in Test 2). After passage three of supernatants initially negative by titration, FMDV sample positivity increased to 8/36 and 21/36 for Tests 1 & 2 respectively. This study provides novel efficacy data on the ability of iHP to inactivate FMDV and ASFV dried on surfaces commonly found in BSL3-Ag containment facilities and laboratory spaces. Additional applied biosafety research is needed to determine effective iHP exposure condition to obtain complete inactivation of FMDV on concrete.

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Biological Incident Response: Building Knowledge Through Operational Testing and Exercises

Katrina McConkey | U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) strives to protect human health and the environment from adverse impacts resulting from incidents involving biological outbreaks or the intentional release of threat agents. Over the last 15 years several interagency efforts have been conducted to advance the technologies used to characterize and decontaminate indoor and outdoor areas following biological contamination. Collaboration between the U.S. EPA Office of Emergency Management and Office of Research and Development has resulted in the execution of several field exercises and operational tests that have



helped identify effective methodologies to implement during an actual biological incident, as well as knowledge gaps to consider for subsequent testing. The operational tests include field-scale studies focused on sampling, decontamination, waste management, and cost analysis information for the remediation of indoor and outdoor areas as well as subway systems. The areas included, but were not limited, to large structures and buildings; rolling stock (railcars) and physical structures (tunnels and stations) of an underground transit system; commercial livestock production facilities; and federal government assets and facilities. This poster will provide a high-level overview of some operational tests and exercises that the U.S. EPA has conducted, and the lessons learned for future capability enhancements in biological incident response.

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Empowering Citizen Resilience: ChatGPT-Enhanced Platform for Unified Incident Reporting and Health Security

Ahmad Patooghy | *North Carolina A&T University*

Introduction: In the intersection of public health, environment, and community, empowering citizens is paramount. Our proposed platform harnesses the capabilities of ChatGPT to integrate waste, hazard, and power outage reporting, fostering citizen resilience, information sharing, and decision support. Aligned with the National Biodefense Strategy, it empowers citizens and residents to drive preparedness efforts.

Features: Our platform aims to streamline incident reporting by unifying concerns with citizen engagement. Powered by ChatGPT, it enables effortless incident reporting through citizen-generated SMS-messages, embodying Strategy's collective action emphasis.

Information Sharing and Health Security: The platform prioritizes public health and environmental information security. Facilitating secure data exchange strengthens collaborative responses aligned with the Strategy's "One Health" framework. This measure safeguards shared information, fostering trust among citizens, responders, and authorities. The platform's secure approach underscores its commitment to effective and confidential incident reporting, resonating with the Strategy's holistic approach to health and security.

Empowering Decisions: Beyond reporting, the platform readies communities for crises, aligning with Strategy's call for comprehensive preparedness. The proposed platform extends its value to a spectrum of stakeholders crucial in emergency management and security. The platform equips diverse professionals for strategic, data-driven actions, aligning with the Strategy's preparedness ethos. We intend for users to have supplemental access to tools for informed choices, drawing from COVID-19 lessons.

Community-Driven Engagement: Our hope is for the SMS-based platform to empower citizens to fortify community health and resilience. It mirrors Strategy's public involvement vision in countering biological threats, embracing diversity through ChatGPT's multilingual support.

Conclusion: Our unified reporting epitomizes public health, citizen engagement, information sharing, and decision support. Aligned with the National Biodefense Strategy, it rallies empowered citizens, resilience, and collaborative health security.

Key References:

The 2022 National Biodefense Strategy: <https://www.whitehouse.gov/ostp/news-updates/2022/10/18/the-2022-national-biodefense-strategy-builds-upon-administration-st-priorities-for-pandemic-preparedness/>

Open AI ChatGPT: <https://openai.com/chatgpt>

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(Student)

Evacuation Order Effectiveness and Community Behavior: Enabling Strategic Data-Driven Decision Making Through Big Data

Harsh Anand | *University of Virginia*

Enforcement of hurricane preparedness plans, such as the issuance of evacuation orders, is an imperative step toward reducing social vulnerability, in terms of both human suffering and economic loss. Yet are these evacuation orders actually effective? To address this question, our study (1) analyzes evacuation decisions as a function of government-issued evacuation orders and (2) examines how the evacuation



behavior of communities varies based on socio-economic and demographic factors. We also investigate "shadow evacuation" patterns to understand evacuation order responses in areas without evacuation zones and areas with evacuation zones but no orders. Utilizing big data—comprising high-fidelity mobility and demographic information—our analysis aims to uncover the interdependence between emergency management and community mobility. The insights can help emergency managers and policymakers develop a strategic decision-support aid to maximize the effectiveness of evacuation orders.

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PHILIS Analytical Methods for the Analysis of Chemical Warfare (CWAs) and Future Generation Agents (FGAs) in Environmental Samples

Thomas Fowler | CSS, Inc.

Objective: Presentation of current analytical method capabilities with detection limit and data quality objective information that are utilized by PHILIS for the determination of chemical agents (A-230, 232, and 234, GB, GD, HD, GF and VX by GC-TOF Mass Spectrometry (GCMS-TOF) and UPLC/MSMS.

Significance: PHILIS primary mission is to provide support for consequence management during an incident of national significance. PHILIS must rapidly deploy mobile laboratory assets and subsequently analyze samples for chemical agent in the field and provide rapid turnaround of analytical data.

Equipment used: Agilent 7890/ LECO Pegasus BT GC-TOF and Thermo ALTIS UPLC triple Quad.

Experimental Procedures: The presented methods include procedures for the preparation and analysis of agent in liquid, solid and wipe matrices by GCMS-TOF and UPLC/MSMS.

Results Obtained: The results range from sub parts per billion ppb) for GCMS-TOF to low parts per trillion (ppt) for UPLC/MSMS. Sample preparation via UPLC is significantly less time consuming than for GCMS-TOF (30 min. total/ 1.5 hours total), because UPLC/MSMS does not require concentration during prep. UPLC/MSMS reporting limits are approximately 100x lower than GCMS-TOF. PHILIS methods can deliver low level reporting limits to support evaluation of contamination that is less than established remediation civilian clean levels.

Conclusions: Both UPLC/MSMS and GCMS-TOF methods are viable quick turn methods capable of producing legally defensible data. UPLC/MSMS affords quicker prep times and significantly lower reporting limits.

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(Student)

Assessing Waste and Recycling Practices: A Comprehensive Audit at Xavier University

Savannah Mays | U.S. Environmental Protection Agency

Xavier University is a small, private university (6,000 students enrolled) in Cincinnati, Ohio. Xavier has had a recycling program for years but there has not been monitoring or metrics to evaluate its performance. A waste and recycling audit is being conducted over Summer 2023 to gather initial data and develop an understanding of the current waste management program. The audit is organized in three phases: (1) observation and data collection, (2) interviews with facility/staff and students, and (3) a written report of findings and suggestions to improve the recycling program. In Summer 2023, every recycling and waste bin was manually accounted for throughout all 55 buildings that lie on the 2.4 million square foot campus. Their locations, contents, labeling, and bin types was recorded. Observations made during Phase 1 found there to be an unofficial categorizing system through the janitorial team's color-coding of bags for trash or recycling. This system was not always followed which led to mismanagement of recyclable materials in some instances. For future surveys, the relationship between specific waste types, the consistency of color-coding, and their final disposal destination is recommended. This would help the university better understand where there is a lack of awareness for both the students' disposal habits as well as the staff's proper management of waste streams. Xavier interviews were conducted with facility/staff members and students that expressed their concerns and suggestions regarding waste and recycling practices on campus. As of August 2023, interviews are still being conducted. It is hoped that this initial audit will prompt Xavier University to improve and expand recycling on campus and establish quantitative recycling goals to work towards.



Remove Per- and Polyfluoroalkyl Substances from Water Using Ion Exchange Coupled with UV/Sulfite Reduction

Bingchuan Liu | *University of North Carolina at Charlotte*

Per- and polyfluoroalkyl substances (PFAS) are a group of anthropogenic fluorinated organic matter that are persistent, bioaccumulative, and toxic. The ubiquitous presence of PFAS in various environmental media, especially drinking water sources, has raised major health concerns from the public. While several chemical destructive processes are proved effective for PFAS defluorination and detoxification, the low PFAS concentrations (ng/L levels) in typical contaminated drinking water sources make it inefficient and costly to treat PFAS directly in drinking water via chemical destruction. Instead, PFAS can be concentrated from contaminated drinking water sources by ion exchange (IX), and the waste streams from the IX process with elevated PFAS can be further chemically treated to achieve PFAS detoxification. Therefore, a PFAS treatment train with IX followed by chemical destruction was designed and evaluated. The study included two objectives: (1) assess several common advanced oxidation/reduction processes for their capabilities of homogeneous PFAS defluorination; (2) evaluate PFAS defluorination in three variations of the treatment train: heterogeneous PFAS defluorination on spent IX resins, homogeneous PFAS defluorination in waste resin regenerant, and homogeneous PFAS defluorination in distilled waste regenerant. PFAS mineralization was found the most effective with the following design of the treatment train: capture PFAS by IX resins, regenerate PFAS-loaded resin with a mixture of methanol and sodium chloride solution, distill the waste regenerant to remove methanol, and destruct PFAS in the still bottoms via advanced reduction in UV/sulfite treatment. The whole treatment train was evaluated in terms of PFAS defluorination with various PFAS structures in different water matrices (ultra-pure water, groundwater, and surface water), using one PFAS-specific resin and one generic resin. Water matrix effects from surface water and groundwater on the treatment performance were evaluated against ultra-pure water, and the reusability of resins for the entire treatment train process was also evaluated.

Balancing Efficacy with Environmental Responsibility: Independent Testing of Nano-Enhanced Disinfectants

Thomas Cellucci | *JPI International*

Metal nanoparticles offer many advantages over conventional biocides. They are relatively simple and inexpensive to produce, free from requiring complicated organic syntheses, expensive feedstocks, and large chemical plants. Yet they can be very efficient at low levels as anti-viral, anti-bacterial, and anti-fungal agents.

However, some metals have shown the same environmental issues as their chemical counterparts. Silver nanoparticles, for example, are known to be deadly to aquatic life, requiring their discharges to be tightly controlled or even resulting in the material being excluded from use. Other metals, notably iron and copper, show promise but they must be vetted before use.

Here we present the results of such testing on our copper and iron nanoparticle products. In order to ensure objectivity, all of this testing was done by outside accredited facilities. These include both a national lab and a FDA-approved testing provider.

Developing Auditable Sample Tracking and Recording for Use During CBR Recovery

Ian Shortman | *UK Defence Science and Technology Laboratory*

Ensuring auditability of samples is a challenge, and one which must be met to ensure decisions in the remediation process are defensible. Samples must be taken based on sampling plan locations, and results reported against the correct samples.

We present the adoption of a “cradle-to-grave” approach to sampling. We consider human factors when taking samples and adopt an approach that can accommodate across-hotline changes and common errors such as sample transposition. Our approach ensures the samples that were planned and those actually taken can all



be correlated with laboratory test results. This is particularly beneficial when multiple agencies are involved in conducting operations and conducting analysis.

We are developing a database with a webpage interface to assign identifiers and track samples through to the outputs for production of sampling result heat-maps. This approach addresses multiple needs, including accurate labelling, tracking progress of sample analysis, interoperability with laboratories and allowing for sample location definition.

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Characterizing *Bacillus globigii* as a *Bacillus anthracis* Surrogate for Wastewater Treatment Studies and Bioaerosol Emissions

Willie Harper, Cindy Andujar, Kyle Eckhoff, & Leigh Durden | *Air Force Institute of Technology*

This study characterized *Bacillus globigii* (BG) as a *Bacillus anthracis* Sterne (BAS) surrogate for wastewater treatment-related studies of UV inactivation, adsorption onto powdered activated carbon (PAC), and bioaerosol emission. The inactivation of BG was faster than that of BAS in DI water (pseudo first-order rate constants of 0.065 and 0.016 min⁻¹ respectively) and in PBS solution (0.030 and 0.005 min⁻¹ respectively). BG was also removed more quickly than BAS by PAC adsorption in DI (0.07 and 0.05 min⁻¹ respectively) and in PBS (0.09 and 0.04 min⁻¹ respectively). In DI, BG aggregated more ($P < 0.05$) than BAS when the pH was 7 or greater but there were no statistically significant differences in NaCl solution. Spore aggregation was also studied with Extended Derjaguin-Landau-Verwey-Overbeek (xDLVO) models. Less than 1% of all spores were released as bioaerosols, and there was no significant difference ($P > 0.05$) in emission between BG and BAS. To the author's knowledge, this study is the first to demonstrate that BG is a suitable surrogate for BAS for bioaerosol emissions, but a poor surrogate for both UV inactivation and PAC adsorption. These results can be used to understand the ability of BAS to act as a surrogate for BA Ames because of its genetic and morphological similarities with BAS.

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Multi-Component Decontaminants for Neutralization of Toxic Materials in Challenging Conditions

Mark Tucker | *Artemis AG-Solutions, LLC*

Decontamination of toxic materials in real world situations can be very challenging for many reasons. First, a decontaminant must be broad-spectrum so that a single formulation can neutralize a variety of toxic chemicals such as chemical warfare agents, toxic industrial chemicals, carcinogens on firefighter turnout gear, and illicit narcotics (e.g., methamphetamine and fentanyl) as well as important pathogens such as bacteria, biofilms, and viruses. Second, the formulation must work on both porous and non-porous materials such as steel, rubber, painted surfaces, cloth, and more. Next, the formulation must not be toxic to humans or corrosive to equipment. Fourth, it must be able to be deployed by a variety of methods (e.g., liquid, foam, spray, fog, etc.) for use in a wide range of scenarios. And finally, the formulation must work in the presence of soil and organic loads and bodily fluids which are typically found in real world environments and which often inactivate many decontaminants and disinfectants rendering them ineffective. If a decontaminant does not possess these properties, potential users must employ multiple formulations which is not typically a practical and/or cost-effective approach to mitigate hazardous events. Most existing decontaminants do not meet these criteria for an ideal formulation. These decontaminants typically rely on a single reactive species in an aqueous formulation that may perform well in laboratory tests but fall short in real world use. One example is sodium hypochlorite that is easily inactivated by high soil or organic loads making it much less effective (or even ineffective) in actual use. Therefore, more effective decontaminants are needed. Artemis Bio-Oxygen meets the criteria for an ideal decontaminant. Artemis Bio-Ox contains multiple components including several reactive ingredients, detergents, mild organic solvents, and pH buffers to enhance its efficacy against highly toxic chemical and biological materials in real world scenarios. This combination of ingredients gives Artemis Bio-Ox a broad-spectrum decontamination capability against many toxic materials, enables it to be effective on many surfaces, provides low toxicity and corrosivity properties, allows for multiple deployment methods, and enables



it to be used in the presence of high soil and organic loads. This presentation will describe the superior performance of multi-component decontaminants against toxic materials of interest.

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Importance of Proper Methodology for Evaluating the Efficacy of Chemical-Based Antimicrobial Air Treatment Products Against Microbial Pathogens

Gedi Mainelis | *Rutgers University*

Accurately assessing the efficacy of products claiming to inactivate or control airborne microorganisms of public health concern is of paramount importance. This presentation will focus on key methodological aspects for evaluating the efficacy of chemical-based antimicrobial air treatment products. By developing and applying testing procedures that align with the intended product application pattern, the test methods will provide a more accurate assessment of a product's effectiveness for killing microbial pathogens, including bacteria, viruses, and fungi.

At the heart of the rationale for the proposed and discussed testing approach lies an understanding of the factors governing the interaction between an antimicrobial agent and target organisms. The efficacy of antimicrobial agents hinges on many variables, including the physical states of both the target microorganism and the antimicrobial agent, their concentrations, and ambient environmental conditions. How a chemical-based air treatment product contacts airborne pathogens and its mode of action are key considerations when designing efficacy studies.

The presentation will discuss some of the theoretical reasons why a study that aerosolizes both the test organisms and the air treatment product will provide a better estimate of the antimicrobial efficacy of such products than the traditional surface-testing approach by exposing coupons plated with test microbes to the test substance. We will also report the significantly different results seen in side-by-side testing of several compounds against the same microorganisms on coupons vs. their use in the air against airborne organisms.

Microbial species generally recommended for testing the efficacy of antimicrobial agents typically fall in the BSL-2 category. However, due to safety considerations, in the U.S., such species may be aerosolized only in a BSL 3-rated facility. Unfortunately, there are few commercially available BSL 3 facilities in the U.S. capable of conducting such testing, which severely limits the development of advanced antimicrobial air treatment products. Thus, we will present a framework using species' phenotypic characteristics to identify appropriate surrogates and data showing that they appear comparable in sensitivity to the species that EPA typically expects to be tested.

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Centering Equity in Community Resilience

Ian Reilly | *U.S. Environmental Protection Agency*

Hazardous and polluting sites have historically been disproportionately sited in low-income and underrepresented communities, placing these communities at the frontlines during contamination events. Coupled with the increasing threat of other disasters like flooding and extreme heat, these communities have an even greater need to build resilience. Unfortunately, few tools exist that address the important connection between social vulnerability, equity, and resilience. The Equitable Resilience Builder (ERB) was developed by the U.S. Environmental Protection Agency's Office of Research and Development to address this need. The ERB tool is designed to help local planners and decision-makers build community resilience by guiding them through all phases of a resilience building process from identifying and recruiting members to the core team and setting goals to implementing community prioritized resilience projects.

ERB centers equity in resilience planning processes by guiding users through identifying and conducting outreach to disproportionately impacted community members, reducing barriers to engagement, and actively encouraging participation in workshops. ERB encourages users to recognize traumas that exist among members of their community and actively work to understand the root causes of social, economic, and health inequities that contribute to them. ERB utilizes established social science practices like storytelling to promote respect and empower local voices, particularly those that have been historically underrepresented, underserved, and disproportionately impacted by hazards. Additionally, ERB users are regularly prompted to



reflect on their progress and re-evaluate if any community perspectives are missing from workshop activities so that they can actively work to fill such gaps with appropriate voices. Through emphasizing community engagement, empowering local knowledge, and respecting and incorporating underrepresented perspectives from the community the ERB helps users build a stronger sense of community trust and develop resilience plans and projects that have benefits equitably distributed across the community.

Decontamination poses significant challenges to U.S. communities, particularly those that experience significant equity challenges. In this presentation, we will detail specific ways that ERB incorporates equity in resilience planning and explain how decontamination practitioners can apply ERB to their own work.

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Facilitating Early Adoption: Assessing the Sustainability of Alternatives to Petroleum-Based Ion Exchange Resins

Lewis Rowles | *Georgia Southern University*

The global market size of ion exchange resins (polymeric beads) for water treatment on an annual basis was estimated at U.S. \$3.4 billion and is projected to reach US \$5.85 billion by 2028. Many ion exchange resins used for water treatment are petroleum-based, often synthesized from styrene and divinylbenzene derived from petrochemicals. Resins are polymeric structures that can be functionalized to carry specific ions, enabling ion exchange. Spent ion exchange resins, initially used for contaminant removal from water, might undergo cycles of use and regeneration; however, they degrade and lose effectiveness over time. In addition to the disadvantage of being synthesized from petrochemicals, spent resins may disintegrate, forming microplastics, posing additional environmental challenges. Disposal requires careful consideration due to potential hazardous content, with methods including incineration, landfilling, or hazardous waste treatment. Water treatment technologies are evolving unprecedentedly, driven by the urgent need to safeguard our water resources. Among the promising solutions are biopolymeric beads, which offer environmentally friendly and effective alternatives to conventional water treatment methods. Biopolymers (such as cellulose, chitin, and their derivatives) are known for their abundance, biocompatibility, biodegradability, and non-toxicity. Numerous studies have demonstrated using biopolymeric beads in water treatment to effectively remove contaminants such as ions, metals, organic compounds, and recently, per- and polyfluoroalkyl substances (PFAS). Although biopolymeric beads are explored as alternatives to synthetic polymers in water treatment, their relative sustainability compared to their petroleum-based counter parts remains unclear. Here, we assess the costs and environmental impacts of biopolymeric beads for water treatment through techno-economic analysis and life cycle assessment, respectively. Tradeoffs between usable lifetime, selectivity, and regeneration efficiency are explored to help highlight potential opportunities and future research needs. This initial evaluation focuses on chitosan derived beads for the removal of model organic pollutant, methylene blue, with opportunities to expand this framework to other biopolymers and contaminants highlighted. This work aims to help inform conversations on whether it is time to consider a pivotal shift toward the early adoption of sustainable alternatives to petroleum-based resins.

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A Case Study on Emergency Response Planning Using SWMM: Evaluating the Transport of Biological Agents under Different Rainfall Scenarios and urban Surfaces

Lifeng Yuan | *U.S. Environmental Protection Agency*

The U.S. Environmental Protection Agency's Storm Water Management Model (SWMM) was used to evaluate the potential concentrations and migration pathways of spores spread by urban stormwater following a hypothetical biological agent terrorist attack or accidental pathogen release at the U.S. Coast Guard Base Elizabeth City, North Carolina, using a 6-hour natural rainfall event on Dec. 8, 2021 and two design storms (2-year and 100-year return period events). The SWMM model was built using data from digital elevation model (DEM), land use and land cover (LULC) map, soil map, urban drainage system engineering files, and a point-scale field study that measured spore concentrations in natural stormwater runoff from different urban surfaces: asphalt, grass, and concrete. The model was calibrated using an exponential washoff function and the observed spore concentrations from the field study. The calibrated model was then used to



simulate spore concentrations in runoff under different rainfall scenarios, including a natural rainfall event and two design storms. The results showed that concrete surfaces generated higher average spore concentrations (175%, $p < 0.05$) than asphalt surfaces, both in the simulated scenario and in the field experiment. The calibrated washoff coefficient (c_1) and exponent (c_2) were 0.01 and 1.00 for asphalt, 0.05 and 1.45 for grass, and 2.45 and 1.00 for concrete, respectively. This study highlights the workflow of SWMM spore contamination model construction and demonstrates the potential use of SWMM for emergency planning and remediation by evaluating spore washoff from urban surfaces under different rainfall conditions.

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Rapid Inactivation of SARS-CoV-2 Using Vaporised Hydrogen Peroxide

Thomas Pottage | *UK Health Security Agency*

SARS-CoV-2, the causative agent of COVID-19, is transmitted via the aerosol route and from larger sprayborne droplets from infected individuals. Infectious particles generated by an individual will be, in the case of exhaled aerosols or nasopharyngeal secretions, associated with high salt and proteinaceous matrices which can provide protection to the agent against environmental stresses and decontamination methods. Gaseous decontamination has been proposed for surfaces in laboratories, healthcare and for used PPE (to allow reuse), but little data is available on the inactivation of SARS-CoV-2 when presented in media that mimics human nasopharyngeal secretions. In this study vaporised hydrogen peroxide (VHP) was investigated for its ability to inactivate SARS-CoV-2.

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A New High Hazard Chemical Decontamination Line

Anne A. Busher | *CSS, Inc.*

Decontamination (decon) is the process of removing or neutralizing contaminants accumulated on personnel and equipment. The decon process is critical to worker health and safety at hazardous waste sites. Decon procedures protect workers from hazardous substances that may contaminate and eventually permeate protective clothing, respiratory equipment, tools, vehicles, and other on-site equipment. Through a series of steps and stations, the Decontamination Line (DL) moves the Exclusion Zone Worker (EZW) from the site Exclusion Zone (EZ) through the Contamination Reduction Zone (CRZ) to the Support Zone (SZ).

The procedures presented in this poster accomplish the following objectives:

- Safely remove personnel from PPE without contaminating them.
- Protect site personnel by reducing the spread of harmful materials into clean areas.
- Select the appropriate decon solution for the contaminant of concern.
- Protect the community by preventing the uncontrolled transport of contaminants from the site.

Decontamination Line:

This Personnel DL was developed for use at the EPA OTECRA (Operational Testing and Evaluation of Chemical Remediation Activities) Demonstration as an appendix to the Site Health and Safety Plan (HASP). The OTECRA Demonstration tested and evaluated remediation response capabilities following an incident with a highly toxic and persistent chemical in an indoor facility.

EPA developed the DL so that it was scaleable for any event, using any level of personal protective equipment, and using commercial off-the-shelf technology. EPA modified their existing Chemical Weapons Agent (CWA) Hazardous Chemical Warfare Agent Personal Decon Line SOP so that all EPA regions have consistent methods for removing toxic chemicals.

The OTECRA decon line used a wipe, spray, and rinse decon line process. It focused on personnel wearing Level C PPE, air purifying respirators (APR), powered APRs (PAPRs) and Level B PPE with self-contained breathing apparatus (SCBAs). It was set up before any personnel or equipment entered the EZ and CRZ areas where the potential for exposure to hazardous substances exists. Most importantly, it successfully



demonstrated that EPA could scale the decontamination process to meet various personnel numbers while maintaining high confidence in the decontamination process.

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Evaluation of a Chemical Reductant Commercialized as MuniRem® for Neutralization and Destruction of CWAs in CWM Stockpiles

Valentine Nzengung | *MuniRem Environmental LLC*

The chemical weapons stockpile, obsolete and discarded chemical weapons contain two main types of chemical agents: (1) cholinesterase inhibiting nerve agents (GB and VX), and (2) blister agents; primarily various forms of mustard agent (H, HD, and HT). The agent which has been produced and stored the most is mustard agent also known as mustard gas or bis(2-chloroethyl) sulfide or Yperite. These chemical agents are predominantly organic compounds which are weaponized due to their high toxicity. The demilitarization and remediation of CWA is limited by the availability of safe and cost-effective technologies that degrade the CWAs without forming and accumulating harmful by-products. We have evaluated the application of a chemical reductant commercialized under the name MuniRem® to simultaneously neutralize and destroy CWAs in CWM stockpiles while simultaneously destroying explosives in military munitions to non-hazardous end products.

MuniRem was evaluated in bench scale tests as a rapid and safer alternative neutralent for destruction of neat Sulphur mustard and the mustard simulant, 2-Chloroethyl ethyl sulfide and the sarin simulant, diethyl (methylthiomethyl) phosphate. The test results indicated that a suitably formulated aqueous solution of MuniRem reagent destroyed >99% of the simulants in <1 hour without leaving hazardous products. The degradation of Sulphur mustard in the presence of sand and metal (iron) is expected to be more efficient than in the homogeneous samples, an indication that the MuniRem reagent is potentially effective for soil remediation where mustard and soil minerals are present at the same time.

The National Academies of Sciences, Engineering and Medicine (NASEM) and the United States Environmental Protection Agency have recently designated MuniRem among the solutions that are considered mature alternatives to Open Burning/Open Detonation for the Demilitarization of Conventional Munitions. MuniRem products are already commercially available and applied in the United States and internationally to support demilitarization contracts, facilities decontamination and routine cleaning of energetics manufacturing equipment and buildings.

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Scoping Review on Procedures Used to Evacuate or Decontaminate Patients During a Chemical Incident Who are Either Unable to Understand Instruction or Unable to Perform Activities Without Assistance

Theodore Ruff and Joe Padayhag | *Centers for Disease Control and Prevention*

Following a hazardous chemical incident, individuals who are exposed to the chemical(s) and those in or near the affected area may have to evacuate and/or decontaminate to mitigate any negative health effects. The Primary Response Incident Scene Management (PRISM) series was developed through funding from the Office of the Assistant Secretary for Preparedness and Response, Biomedical Advanced Research and Development Authority to provide guidance for emergency response with a focus on public health. The guidance describes three categories of patients:

- C1: Patients who can understand instructions and perform activities without assistance.
- C2: Patients who are either unable to understand instructions or unable to perform activities without accommodations or assistance.
- C3: Patients who are unresponsive, have life-threatening injuries, or require extensive accommodations or assistance.

The PRISM series cite evidence that moving C2 patients through the decontamination process requires an increase in the number of first responders and any delay resulting from the need for additional responders may



have a negative impact on all patients in terms of clinical and operational effectiveness, which further highlights the need to develop more effective protocols for C2 patients.

The authors conducted a scoping review to determine what research has been conducted regarding the decontamination and evacuation of C2 patients.

Based on the pre-set research questions, there were a total of 42 articles included for analysis. The most prevalent mass decontamination and evacuation approaches described in this set of literature were wet decontamination techniques (n = 53), followed by dry decontamination techniques (n = 15).

Most of the articles included in this review described or evaluated the decontamination and evacuation approaches on members of the general population (n = 29) with C2 patients were described in four articles.

Nineteen of the 42 included articles included descriptions of communication strategies for performing mass decontamination and evacuation. The majority of these focused on the general population; however, six of the 19 articles described communication strategies for C2 patients.

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FRET Based Biosensors for CBRN Threat Detection

Steven Demers | *Savannah River National Laboratory*

Advanced sensor capabilities for the simultaneous on-site detection of chemical, biological, and radiological/nuclear (CBRN) threats would significantly limit the risk of exposure to personnel and allow for the rapid, in field collection of essential scientific data. One way to accomplish this is to create a multiplexed Förster Resonance Energy Transfer (FRET) based sensor that is capable of simultaneous CBRN detection. FRET based sensors are tailorable, specific, and highly dependent on donor-acceptor distance, where the distance dependence is the key component of FRET based biosensors. The energy transfer was measured between donors (quantum dot and dyes) and acceptors (gold nanoparticles and quenchers) bound by double-stranded DNA aptamers that target specific CBRN threats. Binding of the target analyte to the DNA aptamer causes conformational changes to the DNA structure that alters the donor-acceptor distance, creating a detectable signal change in the fluorescence response. Results for the detection of a sarin metabolite (methylphosphonic acid) in artificial urine, detection of anthrax protective antigen 63 using different biosensor arrangements, and investigations into a greater range of materials for biosensor components and mixing will be presented.

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Rapid Energetic Medical Instrument Sterilization (REMIS)

Zach Minter | *National Strategic Research Institute*

Sterilization of medical tools is typically achieved via an autoclave, which exposes the items to high temperature and steam for an extended amount of time (60-180 min) or utilize biocidal chemicals. These methods, while effective, are time consuming, require bulky equipment, and a continuous supply of power and water, thus limiting the practical use of these systems in field hospital settings and other austere environments. The long cycle times and limited quantity of surgical kits can result in a critical shortage of sterile instruments during mass casualty situations. Sterile storage conditions in austere environments also present unique issues due to storage containers (plastic, paper, etc.) being easily damaged and losing sterility prior to use. According to the Bureau of Medicine and Surgery BUMED, studies on future conflicts show an urgent need for methods that expedite care in mass casualty settings. There is an expeditionary medical need for innovative, rapid sterilization methods to improve surgical equipment turn-over capabilities and reduce potential infectious complications. The development of a power-free, energetics-based device for rapid (≈ 5min) sterilization of surgical instruments and hardware could support this need.

Utilizing prior knowledge of rapid defeat energetic formulations, NSWC IHD developed a program that utilizes an energetics based device for rapid sterilization of surgical equipment called Rapid Energetic Medical Instrument Sterilization (REMIS). REMIS™ approach uses energetic materials and water to create an extremely high sustained temperature output along with the production of biocidal chemicals to achieve effective neutralization of biological agents. The scientist at NSWC IH have teamed up with scientist from the



National Strategic Research Institute (NSRI) and John Hopkins University's Applied Physics lab (JHU-APL) to investigate the potential for utilizing REMIS's approach to support the needs of BUMED surgeons.

Preliminary bio-efficacy testing is being conducted using stainless steel coupons that have been inoculated with either vegetative bacteria or spores, *Staphylococcus aureus* or *Bacillus thuringiensis* respectively. To date, REMIS has shown 8 log reduction in Sa vegetative cells, and a 6 log reduction in Bt spores. Further system development is underway to improve REMIS™ effectiveness against spores.

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Sub-Micron Aerosol Vapor Decontamination Using DryDecon™ Technology

Tyson Bernthal, Jorge Camacho, John Lau | *DryDecon™ Defense*

Our patent-pending DryDecon™ Technology utilizes an innovative method of delivering water-based decontaminant in a way that thoroughly disinfects an area of harmful agents at the sub-micron level. This allows for a more efficient and thorough removal of dangerous agents which linger within the air, hard surfaces and hide deep within surfaces cracks, or fabrics.

DryDecon™ Technology can convert virtually any certified decontaminant solution into a sub-micron aerosol vapor that naturally diffuses throughout an entire enclosed space at scale. This sub-micron aerosol is comprised of a greater number of smaller particles (i.e., less than 1 micron on average) than the type of dense, heavy fog released by traditional decontamination units. This approach allows the decontaminant solution to spread more evenly, reach further/higher distances, and fully treat the space under/behind objects within the treatment area. Unlike other systems, our innovative technology ensures that decontamination procedures can be completed without leaving behind noticeable wetness that must be manually wiped away.

Our DryDeCon™ technology has shown the capacity to surpass traditional forms of decontamination in performance, cost efficiency, ease of operation, versatility, scalability, and durability. At present, our technology has the ability to serve as a single solution for disinfecting against COVID-19, Avian Influenza, *Clostridium difficile* (C. Dif.), *Salmonella*, *Staphylococcus* (Staph), and *Escherichia coli* (E. coli), as validated by a national biological testing laboratory.

DryDeCon™ technology is also proven safe for use in locations that typically produce or handle sensitive products, such as food processing plants or hospitals. By leveraging our approach to decontamination, these integral services could significantly reduce or eliminate the amount of downtime that typically follows a contamination event. The physics of even distribution of sub-micron size aerosol particles is also supported by experiments done by a major University.

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(Student)

Biochar A Sustainable, Multi-Beneficial And Cost-Effective Media to Treat the Stormwater Runoff

Mohammad Khalid | *University of North Caroline at Charlotte*

Highways are considered a major source of pollution to stormwater and its runoff can introduce various contaminants including nutrients, Indicator bacteria, and heavy metals which can have negative impacts on receiving waters. Also, the roadside soil gets compacted over time and can't infiltrate the stormwater through it. The situation becomes worse if it is clay soil resulting in increased runoff. This study assessed the ability of biochar, a carbon-rich byproduct generated from the pyrolysis of biomass, the removal of contaminants and to improve the water-holding as well as infiltration capacity of soil biochar mixture. For this, commercially available biochar was strategically selected. Lab scale batch testing was done to find the preliminary estimate of contaminants removal along with saturated hydraulic conductivity, and water retention capacity. Furthermore, from the preliminary results, the bench scale filtration columns were designed to evaluate the performance of biochar in the long term. Based on specific infiltration capacity soil biochar column packing was done. The testing has been conducted for nutrient, heavy metal, and indicator bacteria analysis over a year, which includes different weathering conditions. The results from saturated hydraulic conductivity show that biochar was able greatly improve the infiltration capacity which is attributed to the high porosity of the biochar soil mixture. The data from the column testing shows that biochar has the ability to significantly remove different contaminants. Overall, this study demonstrates that biochar could be efficiently applied with



clay soil to improve the soil's hydraulic characteristics as well as to remove the pollutants from stormwater runoff.

TECHNOLOGY CAFÉ SESSION

1

Internet Tools for Sourcing Chemistry Related Data

Antony Williams | *U.S. Environmental Protection Agency*

This tech café demonstration will provide an overview of the many online tools available from the U.S. EPA's Center for Computational Toxicology and Exposure which can provide access to rich data streams for over 1.2 million chemical substances. These data include property, hazard and safety data which can be searched based on CAS numbers, millions of chemical identifiers or, when appropriate, by chemical structures. Applications which will be demonstrated include the CompTox Chemicals Dashboard (<https://comptox.epa.gov/dashboard>), publicly available proof-of-concept cheminformatics modules (<https://www.epa.gov/chemical-research/cheminformatics>), and new tools in development. This includes hazard and safety profile modules which integrate publicly available data streams into a web-based interface delivering information regarding nine categories of GHS data (the Globally Harmonized System of Classification and Labeling of Chemicals), details regarding measures of accidental release (including cleanup and disposal), and firefighting measures. Disclaimer: The views expressed in this article are those of the authors and do not necessarily represent the views or policies of the US EPA.

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The Water Sector's One-Stop Reference Tool for Contaminants of Concern

Veronica Aponte-Morales | *U.S. Environmental Protection Agency*

Utilities encounter countless challenges in the face of water contamination incidents. Overcoming these challenges requires proper emergency preparedness and response efforts. To support the needs of the Water Sector, the Environmental Protection Agency's Water Infrastructure and Cyber Resilience Division (WICRD) continues to develop and update emergency response tools and resources to support and enhance the Water Sector's preparedness and resilience. As one of the many tools and resources WICRD offers, the Water Contaminant Information Tool (WCIT) stands out as a one-stop reference tool for the Water Sector's needs during all phases of emergency response.

WCIT is a secure, online database containing information on over 800 contaminants of concern. The contaminant data is presented as profiles with 11 key categories, such as contaminant names (including synonyms), contaminant usage and sources, fate and transport, health effects and toxicity, medical information, early warning indicators, drinking water treatment, sampling and analysis, helpful response advice for utilities, and several other categories of valuable information. The wide range of information in the database aims to support a wide range of activities, such as, but not limited to:

- Assisting in emergency response decision making
- Assessing and understanding contamination threats and consequences
- Identifying appropriate analytical methods for water monitoring
- Gathering information to communicate risks to the public

With features such as printable reports and a risk calculator, the tool can help utilities streamline their response efforts. This presentation will provide an overview of WCIT and examples of its use. However, the heart of the presentation will be a walkthrough demonstration of the database to highlight the tool's functionality and limitations.



Equitable Resilience Builder Demo

Keely Maxwell | *U.S. Environmental Protection Agency*

The U.S. Environmental Protection Agency's Office of Research and Development has recently released a new tool to support community resilience planning called the Equitable Resilience Builder (ERB). ERB is a downloadable application that supports communities in strengthening resilience to disasters and climate change. It walks a core team of users through a guided process to engage community members in resilience planning to generate solutions that address equity. State, Tribal, territorial, county, or municipal government agencies in environment, public health, emergency management, public works, or land use might be interested in using ERB. The core team uses it to plan collaborative workshops to assess hazards, vulnerability, and resilience, and to identify actions to strengthen community resilience in ways that address the needs of those made vulnerable by social and environmental inequalities. For example, a county could use it to help update their hazard mitigation plan to include more information on the social networks created as part of the COVID-19 pandemic and how different neighborhoods experience flooding during heavy rains. In the tools café demo, the audience will be able to check out the electronic version of ERB, which contains five sections: Plan, Engage, Assess, Strategize Action, and Move Forward. They will also be able to try out some of the activities ERB has to offer for resilience planning. ERB activities include: diagram community connections, storytelling, participatory mapping, and indicator card sorting.

Template Tool for Developing Sampling and Analysis Plans for Contamination Incidents Involving Pathogens Using Survey123

Jamie Falik | *U.S. Environmental Protection Agency*

Following an intentional or unintentional release of an environmentally persistent pathogen, remediation of contaminated areas might be required to protect human health and the environment. Remediation can include efforts to determine the extent and location of contamination (site-characterization) and whether decontamination efforts were effective. A well-defined and thorough sampling and analysis plan (SAP) needs to be developed prior to collecting any samples and implemented to collect data that are suitable for decision-making and/or determinations of existing conditions. The SAP defines sample collection and analysis, resulting in data that can be used by the Incident Command, local health departments, decontamination teams, decision-makers and attorneys. The decision and actions taken rely on the quality of the data, and the SAP should include consideration of data quality objectives (DQOs), which are used to ensure that collected environmental data are of known and documented quality for the intended use.

The goal of the MicroSAP Survey123 tool is to assist users with the development of SAPs with incorporated DQOs needed for collection and analysis of samples to support remediation activities (such as site characterization, verification sampling, waste characterization, and post decontamination sampling) following an environmental contamination incident involving pathogens. Data collection activities in which the MicroSAP tool is applicable for sampling and analysis are related to a microbiological contamination incident, research study, or exercise. The survey tool provides a general outline of the essential features that should be included in a SAP. The tool features drop-down menus, fill in the blanks, editable text, and allows the user to view and edit the SAP. The form also allows the user to map locations of where samples should be collected and integrate with other mapping tools. The MicroSAP Survey123 tool was developed through Esri's Survey123 Connect desktop application and an XLSForm advanced template within Survey123. The choice of Survey123 was based on feedback that the Esri product suite is widely used in the response community that support field collection and overall data workflow.

Scenario Specific CBRNE Detection

Evan Durnal | *MRIGlobal*

MRIGlobal created a baseline market survey of detection equipment capable of identifying CWA, BWA, TIC/TIM, Pharmaceuticals, and other Threat materials. Using CBRNE Tech Index, specific performance, operational, and physical criteria were developed to narrow the focus of the survey to those



products best suited for field detection scenarios. The technical approach for compiling product information was to review the open literature (including market surveys compiled by other groups), conduct internet searches, and contact vendors, users, and subject matter experts in the area of field-portable detection products. The scores presented therein are applicable to the described scenarios only. The market survey provides product information for over 1,500 detectors covering 50+ technologies. Products were assigned an overall score based on four categories, 3-5 criteria within each category, weight (importance) of each of 14 criteria, and associated scoring level (1-4) within each criterion. For example, baseline rankings will preferentially select a product with more consumables and durability over size, whereas field users may desire the most portable product available, regardless of durability and consumables. USG users have access to the full data set and the ability to create customized rankings and filtered reports via a secure portal. The portal contains active user customizable ranking whereas the criteria weighting can be independently modified to best represent the user needs and therefore resulting in operationally specific product rankings. In addition, USG users can generate custom reports on all products based on specific search or filter criteria of over 40 unique fields.

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Bio-Chemical Catalysis Solution to Water Decontamination

Michael Omary | APD Clean Water Technologies Group Co

Context: This technology can demonstrate bio-chemical weak-interactions catalysis effective decontamination of surface and ground water. The author has developed a technology called "Smart-Water Ions Filtration Treatment" (SWIFT™) cold reactor modules. Designed for mounting on mobile truck trailers, or retrofit typical urban streets storm-drains or catch basins. SWIFT operates on demand during storm events and emergency floods without mechanical nor human intervention. SWIFT modules powered by reduction/oxidation (REDOX) electrochemical interactions, which, unlock dissolved chemicals' sub-molecular bonds energy. Result in breakdown of toxic chemical bonds' electron dispersion and neutralization of toxic molecules, bacteria and pathogens.

Research Aim: To design and construct mobile and truck mounted SWIFT modules for emergency responses use, to retrofit urban streets storm-water catch basins and drains infrastructure. To capture, decontaminate and disinfect storm-water for local multi benefits use. Including: Ground water recharge, capture and decontamination of toxic water spills due to natural or accidental disasters. Self-sustaining, self-rejuvenating, zero-brine and zero CO₂ discharge desalination.

Methodology: SWIFT modules operate by directing water stream to flow freely through SWIFT biochemical catalysts media cold reactor. Water stream triggers media interactions with water dissolved chemicals, radioactive, electrically conductive organic and inorganic molecules. SWIFT redox interactions result in neutralization of water stream dissolved toxic compounds and molecules electrical conductivity, by unlocking an average of 7 kWh/M³ (8,200 kWh/ac-ft) of urban waste-water.

Findings: The SWIFT™ Technology pilot case studies by California State Universities Presidential Committee for Water Policy Initiatives at, CSU-CI and CSU-Fresno "Water Institute", demonstrated consistent high reduction of all 40 detected waste-water pollutants including pathogens to levels below state of California "Drinking Water Maximum Contaminants Levels". The technology has proved effective in reducing pollutants such as arsenic, beryllium, mercury, selenium, glyphosate, benzene, and *E.-coli* bacteria. Theoretical Importance: Innovative cutting edge advancement to the adoption of clean energy source bio-catalysis water treatment devices. An energy input free, water and waste water desalination and disinfection. A significant contribution toward achieving sustainable, lower cost O&M, zero-brine and zero CO₂ discharges renewable source water treatment and disinfection.

Key Words: bio-chemical catalysis; water treatment; weak redox interactions; storm-water decontamination; emergency response mobile treatment.



Repurposing a Commercial Flight Simulator for Aerial Surveillance Training

Matthew Huyser | *U.S. Environmental Protection Agency*

The EPA funded contract resources to develop a virtual reality-based simulation for training spotters in the conduct of aerial reconnaissance for identifying debris and oiling features in a disaster or spill scenario. An off-the-shelf flight simulator has been modified to include features that a spotter should be able to identify along with a data input tool to simulate the task of recording these observations. The result is a realistic experience that explores visual, temporal, and functional variables of the aerial reconnaissance task. Currently in the prototype stage, the final product will provide a cost-effective solution for routine or just-in-time training.

Next Generation PPE for Real-time Inactivation of Airborne Biological Threats

Christopher Bowers | *XCMR Inc.*

The recent COVID-19 pandemic has created a demand for expanded public health interventions against the spread of airborne disease. XCMR believes that UVC based personal protection equipment (PPE) with continuous inactivation of pathogens as opposed to mechanical filtration offers (i) superior protection to both users and bystanders alike, (ii) reduced breathing resistance and comfort, (iii) reduced ecological footprint by mitigating biohazard waste of disposable masks, and (iv) adaptability to future biological threats.

XCMR has developed a novel form of PPE that integrates germicidal UVC (200-280 nm) into an enclosed reactor to provide a safe, battery powered, wearable device that inactivates pathogens during both inhalation and exhalation leveraging XCMR's Symmetrical Flow Disinfection (SFD) process. Laboratory testing of the prototype reactors included optical characterization and biological analysis using T1 phage which yielded results that aligned favorably with computer simulated models.

Several reactor configurations were produced, each with different types of UVC radiation sources (e.g., LED and Low Pressure Mercury Lamps) at various irradiance levels. A microporous diffuse highly reflective material lining in the reactors produced a near perfect Lambertian reflectance. This resulted in internal irradiance that was significantly amplified, yielding effective inactivation of biological agents.

Aerosolized T1 phage was used as a challenge agent as it is slightly more UV-resistant than common viral pathogens (e.g., coronaviruses and influenza viruses). Air samples collected from the exhaust of the device were subjected to a plaque assay to quantify infective phage concentration with and without treatment. The results of these measurements demonstrated effective inactivation of the viruses in early and final prototype devices.

Further engineering development led to a highly efficient battery operated light engine, microprocessor-based controller with mesh-network connectivity, battery charger, and modular sensor feedback bus integrated into the desired form factor. Human factor design included improved ergonomics and comfort resulting from wearability studies and anthropometric analysis to enable a greater likelihood of user adoption.

These data were used to direct the production of our UVC disinfection systems as wearable, reusable, devices to inactivate airborne pathogens and achieve equivalent or greater protection to an N95 mask.

Enhancing Laboratory Preparedness: Automated Decon Systems for Biothreat and Emerging Pathogen Response

Jeff Woodson | *CURIS System*

Laboratories engaged in biothreat and emerging pathogen response face a critical need for decontamination systems capable of effectively addressing highly challenging environmental pathogens. Many are inadequately equipped, burdened with immense responsibilities, limited in funding, and employing outdated or unsupported equipment with high consequence chemicals. This deficiency extends to the staff with high turnover or lack of proper training. This presentation highlights a new technology which may help meet the need to implement automated decon in laboratories, with emphasis on efficacy, safety, material compatibility of



facilities and sensitive lab equipment, and versatility. During outbreaks, epidemics, and pandemics, time and staffing resources become strained, so the technology should be automated to function without constant monitoring and easy for staff to operate, allowing staff to allocate their resources more effectively. Systems should be versatile and capable of automatically decontaminating entire spaces, enclosures, or closed system equipment, e.g., BSCs. The disinfectant should be a sporicidal agent, leave no residue, be validatable, and comprehensively decontaminate spaces without hesitation or concern. The proposed multifaceted technology uses a 7% hybrid hydrogen peroxide sporicidal agent, tested per the EPA's more stringent tri-part soil load requirement. Its modular unit can be used for closed loop decontamination of equipment and decouple for whole room decon. A single operator can run the system via a touchscreen or remotely via its app, and the lower concentration and operating ppm mean treatment cycles do not require constant monitoring. By automating the decon process, labs can streamline their response efforts, minimize downtime, and maximize operational efficiency, all while ensuring a safe and secure working environment. Attendees will gain insight into this technology through discussion of published studies, videos, and the opportunity for hands on experience for those physically present. In conclusion, the implementation of automated decon systems in labs engaged in biothreat and emerging pathogen response holds immense potential for mitigating risks, improving efficiency, and safeguarding public health. Leveraging innovative technologies, such as the evaluated hybrid hydrogen peroxide decon system, labs can better allocate their limited resources and combat the ever-evolving challenges posed by environmental pathogens.

CONCURRENT SESSION 4 – BIOLOGICAL AGENT SAMPLING & ANALYSIS METHODS

Validation of Air Sampling for SARS-CoV-2 and Mpox Virus Using the Sartorius MD8 Airport

Sean Collins | *UK Health Security Agency*

Isolation of viable SARS-CoV-2 or mpox virus (MPXV) from air samples collected in contaminated environments has been challenging. It is important to determine if viable virus titre recovered is a true reflection of virus quantity in the environment or if sampling or transport procedures have an impact on virus viability. In this study, contaminated Sartorius MD8 Airport gelatine filters were validated to determine the effect of storage conditions and sampling on virus viability and recovery.

SARS-CoV-2 and MPXV were separately aerosolized and used to directly contaminate MD8 gelatine filters. Contaminated filters were used to study various storage conditions: immediate processing, overnight storage at 4°C, and overnight storage at -80°C. Virus titre was enumerated using plaque assay. The effect of the air sampling process on virus viability was studied using SARS-CoV-2. Following contamination, filters were attached to an MD8 Airport sampler that was then operated for different durations (50 L/min for total volumes of 250-2000 L). Contaminated filters were processed immediately with virus titre determined by plaque assay.

A reduction in recoverable SARS-CoV-2 was witnessed on filters not processed immediately. Contaminated filters stored overnight at 4°C, processed, then frozen at -80°C prior to plaque assay resulted in the lowest recovery of viable virus with a 1.5 log₁₀ reduction compared to those processed immediately. In contrast, recoveries of MPXV from contaminated filters were comparable across all of the storage conditions.

Immediate processing of filters resulted in improved virus recovery with all storage conditions affecting recovery for SARS-CoV-2. The duration of air sampling using an MD8 Airport does not appear to affect the recovery of viable virus with similar SARS-CoV-2 titres identified irrespective of sampling time. It is likely that the gelatine matrix protects the viral particles from the desiccating effects of prolonged air sampling.

As most real-world air samples will require transportation and storage prior to laboratory analysis, it is imperative that users fully validate their sampling and processing methods to identify the efficiency of recovery.



Sampling and Recovery of SARS-CoV-2 from High-Touch Surfaces by Sponge Stick and Macrofoam Swab

Megan W. Howard | Battelle

Effective characterization of biothreat agents is a critical component of emergency response operations. In the face of emerging pandemic threats, determining the most effective sampling methods is crucial to developing a common approach to monitoring disinfection efficacy and obtaining useful environmental surveillance data. To evaluate the sampling efficacy of commonly deployed methods against SARS-CoV-2, this study explored the sampling efficiency and limits of detection (LOD) of macrofoam swab and sponge stick sampling methods on both infectious SARS-CoV-2 and viral RNA (vRNA) recovery from surfaces. SARS-CoV-2 was suspended in a 5% soil load and contaminated onto six-inch square coupons of stainless steel (SS), Acrylonitrile Butadiene Styrene plastic (ABS), bus seat fabric, or Formica. Infectious SARS-CoV-2 recovery was more efficient than vRNA recovery for all materials except Formica (macrofoam swab) and ABS (sponge stick). Recovery of vRNA and infectious SARS-CoV-2 virus varied by material, sampling method, and time post-contamination, suggesting that multiple variables should be considered when interpreting surveillance results. Interestingly, the elapsed time post-contamination only significantly affected infectious virus recovery, while vRNA recovery demonstrated limited to no change at up to 2 hours post-contamination. These results suggest that SARS-CoV-2 vRNA remains detectable after viral infectivity has dissipated. This study showed that a complex relationship exists between sampling method, material, time post-contamination to sampling, and recovery of SARS-CoV-2. In conclusion, data show that careful consideration should be used when selecting surface types for sampling and interpreting SARS-CoV-2 vRNA recovery with respect to presence of infectious virus.

Response Planning: Laboratory Support Considerations

Peter Roumeliotis | U.S. Environmental Protection Agency

Due to the growing complexity and multifaceted nature of water security and emergency response, the Water Sector, including water and wastewater utilities, water testing laboratories, and other response partners, are seeing an increasing need for preparedness to all-hazards water contamination incidents. Increasing Water Sector readiness can look like many things, including developing an emergency response plan (ERP), participating in water security training, and establishing a support network. The Environmental Protection Agency's (EPA's) Water Infrastructure & Cyber Resilience Division has developed tools and resources to help the Water Sector navigate and enhance their preparedness.

A possible challenge when dealing with a water contamination emergency is a surge of water sampling and analysis that can quickly overwhelm resources or require laboratory expertise unavailable to most utilities. Proper preparation and planning by utilities are critical for reducing emergency response times and overcoming unforeseen challenges. Hence, including analytical support considerations when developing ERP is a best practice. EPA's Water Laboratory Alliance (WLA) offers free tools and training to assist the Water Sector with implementing analytical support considerations into their preparedness strategies.

When in situations where contaminant analyses exceed in-house capabilities or capacity, what are your options? In this presentation, WLA resources that will assist you set procedures to ensure accessing laboratory that meets quality standards for managing a water contamination incident will be highlighted. WLA's resources include:

- Water Laboratory Alliance Response Plan (WLA-RP).
- Continuity of Operations Plan (COOP) Template.
- Analytical Preparedness Full Scale Exercise Toolkit (AP-FSE).
- Compendium of Environmental Testing Laboratories (Lab Compendium).

These preparedness resources help advance EPA's goal of building a more secure, water-resilient nation. Attendees will leave this presentation with a suggestion of action items to develop or enhance their laboratory support strategy and incorporate it into their ERP.



Environmental Sampling for Mpox Virus in Domestic, Workplace and Hospital Settings

Thomas Pottage | UK Health Security Agency

Following cases of mpox in the UK, air and surface sampling was conducted in different settings associated with positive cases to determine the extent of viral contamination. The sites investigated included residential, office-based, inpatient, and outpatient settings.

Surfaces were sampled using Copan UTM swabs; air sampling was performed using the Sartorius MD8 Airport with gelatine filters. Mpox virus (MPXV)-specific qPCR was used to identify presence of MPXV DNA; viral isolation was used to determine the presence of viable virus.

Widespread contamination was observed in both residential (37/42 samples qPCR positive, 88.1%; viable virus identified in 6/10 samples selected for viral isolation) and inpatient settings (61/80 qPCR samples positive, 76.3%; viable virus identified in 2/4 samples selected for viral isolation including from a bed linen change air sample). In comparison, limited MPXV DNA contamination was identified in both office (3/34 samples positive, 8.8%; no viable virus identified) and outpatient settings (3/32 samples positive, 9.4%; however, viable virus was identified in 1/3 positive samples).

Several factors likely contribute to DNA and viable virus levels observed in different settings including the time spent in that location by an infected patient, the time from contamination until sampling was performed, and the frequency of cleaning within those environments. These data contribute to our understanding of environmental MPXV contamination and may inform infection prevention and control measures in different environments. Similar investigations are required for other emerging pathogens to assist with preparedness activities when cases of high consequence infectious diseases are identified.

CONCURRENT SESSION 4 – HAZARD RESPONSE

Game Over is not an Option: The Application of Serious Games to US Environmental Protection Agency's Emergency Response Mission

Timothy Boe | U.S. Environmental Protection Agency

Jordan Deagen | U.S. Environmental Protection Agency

The significance of disaster response training and exercise activities on emergency personnel are well documented throughout literature. Both have the ability to encourage teamwork, increase training and equipment adequacy, and develop perceptions of job risk. Emergency responder expertise is a direct derivative of training and exercise. The impacts of these activities are bolstered with increasing realism. Nevertheless, training, especially full-scale disaster exercises are expensive, time consuming, difficult to organize, and can be limited in scope. Furthermore, the processes involved in planning and conducting exercises have remained largely the same for decades. Having the ability to implement full-scale exercises with minimal resources and maximum control and quality would be of great interest to the emergency response and scientific community.

Serious games refer to digital or analog games that combine entertainment with other purposes such as education, training, simulation, or behavior modification, leveraging game design principles, mechanics, and technologies to achieve intended outcomes. Serious games have become increasingly popular in recent years due to their ability to provide a safe and controlled environment for trainers and trainees. This presentation will examine how serious games are being used to enhance the U.S. Environmental Protection Agency's (U.S. EPA's) emergency response mission, by improving the ability of the emergency response community to quickly and effectively respond to a range of environmental emergencies, including oil spills, chemical, biological, and radiological releases, as well as natural disasters. This approach supports the protection of human health and the environment by applying serious games in three specific areas: scientific modeling and simulation, emergency response training, and decision-making and strategy development. This presentation will demonstrate a series of simulations and training platforms developed by the U.S. EPA to address each of these topic areas. The presentation will delve deeper into the challenges involved in adopting new



technologies and fostering collaboration with local, state, and federal subject-matter experts. It will also outline the next steps for the U.S. EPA as it seeks to expand its presence in the field of serious games, moving from a "game over" mentality to a "game on" mindset.

Accessing Chemical Hazard and Safety Data via the Internet

Antony Williams | *U.S. Environmental Protection Agency*

In recent years the Center for Computational Toxicology and Exposure at the US Environmental Protection Agency has delivered a number of valuable web-based applications which provide access to a myriad of data types for hundreds of thousands of chemicals. The data include property data, in vivo and in vitro hazard data, exposure data, and numerous other data types of interest to the scientific community. To date the preeminent application to date has been the CompTox Chemicals Dashboard (<https://comptox.epa.gov/dashboard>) which presently delivers data for over 1.2 million chemicals. One aspect of delivering highly functional mature production software systems is the development of proof-of-concept applications to garner community interest in novel ways of interrogating and visualizing data. These tools include the Hazard Profile and Safety Profile modules which integrate publicly available data streams into a web-based interface delivering information regarding nine categories of GHS data (the Globally Harmonized System of Classification and Labeling of Chemicals), details regarding measures of accidental release (including cleanup and disposal), and firefighting measures. This presentation will provide an overview of publicly available proof-of-concept modules and new tools in development delivering access to chemistry-related data to a variety of stakeholders. Disclaimer: The views expressed in this article are those of the authors and do not necessarily represent the views or policies of the U.S. EPA.

Field Demonstration of Unmanned Aerial System (UAS) Waste Debris Volume Estimation

Kent Hofacre | *Battelle*

Battelle and EPA evaluated the effectiveness of UAV platforms to perform volumetric measurements of various types of debris (e.g., biomass such as fallen vegetation, stacks of building material, and other debris) using lidar and structure from motion (SfM) photogrammetry. The challenge of this experiment is to compare the chosen platform's measurements to a more accurate method, which may not exist. The evaluation approach included three phases. Phase 1 included data collection of simple structures and materials of known volume, such as piles of wood pallets that can be accurately measured by hand and configured into different shapes. The pallets were used to establish a "reference cube" that could be surveyed next to varied materials in each subsequent step. Phase 2 included larger piles such as fallen tree debris pushed into a more compressed pile (with excavators) as well as raw fallen trees, stacks of recycled lumber, pipes, and other miscellaneous items. Overall, the goal was to first establish that the UAS remote sensing methodologies could accurately measure volumes of simple structures which can be validated by hand. In Phase Two, we sought to evaluate the differences in volumetric measurements of more complex piles while also establishing if UAS-based surveys are advantageous as the literature notes it should. In addition to validating remote sensing methods with hand measurements, we evaluated UAS-lidar versus UAS-structure from motion (SfM) surveys and Global Navigation Satellite System (GNSS) mapping using a rover station. The various methodologies will be evaluated against one another for accurately estimating volume, applicability in the field, and collection time. Phase 3 included survey of previously un-surveyed area used as a test bed to determine the effectiveness of the platform to survey piles that had previously been unplanned and unmeasured.

The goal of this project was not to spend unlimited time seeking the most accurate measurements possible for UAS remote sensing methods, but rather to establish a reasonable level of improved accuracy in volumetric measurements over the current ground methods. Best practices included using a GPS base station on site, ground control points, employing flight parameters to gather dense point cloud data, and employing established point cloud error reduction techniques during post processing. Percent differences between air and ground volumetric measurements will be presented.



PHILIS Mobilization Response to East Palestine Train Derailment

Sang Chung | CSS, Inc.

Objective: Summarize the Portable High-throughput Integrated Laboratory Identification System (PHILIS) response and hybrid operational support for the train derailment in East Palestine, Ohio. The Train Derailment Emergency Response Action included laboratory and staff mobilization, method development, sample preparation and analysis, data reduction and reporting. On February 3, 2023, a Norfolk Southern train carrying toxic chemicals derailed in East Palestine, Ohio. Region 5 EPA identified the following list of hazardous materials of concern: vinyl chloride, butyl acrylate, ethylhexyl acrylate and ethylene glycol monobutyl ether. PHILIS chemists developed methods to provide analytical support for the emergency response action and deployed mobile labs to Columbiana, Ohio to provide rapid turnaround results to support spill response cleanup operations. More than 1,500 soil, sediment and groundwater samples have been analyzed to-date in support of remediation efforts. Cleanup efforts will continue through the end of the year and possibly into 2024. Due to the health and environmental concerns associated with the materials released into the environment because of the derailment, the ability to provide accurate and timely results was very important for this project. PHILIS possesses the unique ability to provide quick analytical turn-around-times while mobilized at a site and generate legally defensible data and Level 4 data packages.

Mobile laboratories were mobilized to Columbiana, OH, where PHILIS performed on-site analytical work for the project. GC/MS instruments were used for the analysis of vinyl chloride, benzene, n-butyl acrylate, 2-ethylhexyl acrylate and 2-butoxyethanol. An additional instrument was utilized for the analysis of full list 8270E samples that were presented for analysis from local farmer's fields. Samples were received, logged in, prepared, analyzed and the data reduced and reported within 12 -24 hours of receipt, depending on priorities established by the EPA Project Manager. PHILIS implemented hybrid operations that consisted of on-site staff performing sample receiving and processing, preparation, and instrument analysis. Remote support was provided for the peer review of analytical results, reporting, quality assurance confirmation, preparation, and issuance of all data reports/packages. PHILIS utilizes CISO security, site to site VPN over AT&T FirstNet First Responder cellular network and warehouse facility internet.

CONCURRENT SESSION 5 – BIOLOGICAL AGENTS: DECONTAMINATION II

Comparison of Commercially Available Electrostatic Sprayers and Decontaminants for Personnel Biological Decontamination

John Archer | U.S. Environmental Protection Agency

The personnel decontamination (decon) line is an essential part of emergency response efforts following a biological agent release for ensuring containment and minimizing exposure risk to potentially biohazardous materials on responder personal protective equipment (PPE). EPA has been conducting personnel decontamination research for biological agents through investigation of sprayer applications, including electrostatic sprayers (ESS), to inform response personnel on effective decon line practices and data-driven decision making. The use of ESS may offer several advantages over conventional decon spray applications by simplifying personnel decon and minimizing reaerosolization and aqueous-based waste generation.

Pilot-scale studies with manikins in PPE were conducted for evaluating surface decontamination efficacy using multiple commercially available ESS to simulate a portion of the personnel decon line. Manikins were outfitted with Level C PPE and inoculated with approximately 107 *Bacillus atropheous* var. *globigii* (Bg) spores in seven distinct areas. Manikins were then sprayed for a specified time using combinations of electrostatic sprayer types (battery-powered handheld and plug-in types) and commercially available liquid decontaminants (10% diluted bleach, hydrogen peroxide-based, and peroxyacetic acid-based products). The entire manikin surface was wipe sampled to evaluate decontaminant efficacy for each location, which was determined by comparing the average number of colony forming units (CFUs) from manikin positive controls to the average number of



CFUs from decontaminated test manikins. Reaerosolization during the spray process was measured by collecting high-volume air samples and enumerating for CFUs.

Results indicate effective decontamination ($> 6 \log_{10}$ reduction) was achieved with the plug-in type ESS using 10% diluted bleach. Effective decontamination was not observed with any combination of the battery-powered handheld ESS and decontaminant chemistries, including diluted bleach. The hydrogen-peroxide and peroxyacetic acid-based decontaminants were not effective in this testing, no matter the ESS used. No measurable liquid runoff was observed for any ESS and reaerosolization from the ESS spray decontamination was minimal. Results from scale-up efforts to an ESS automated decon shower will also be reported on. These results provide important data to inform the design and setup of personnel decon lines following a biological agent release.

New Method for *Legionella pneumophila* Claims in Cooling Tower Water

Lisa Smith | U.S. Environmental Protection Agency

Legionella pneumophila is a bacterium that is often identified as the causative agent of Legionnaires' Disease, which is a disease acquired by inhaling water droplets contaminated with *Legionella* bacteria. *Legionella* are found naturally in freshwater environments but can become a health concern when they grow and spread in human-made building water systems like cooling towers. Cooling towers are a potential breeding ground for *L. pneumophila* and subsequent aerosolization of *L. pneumophila* can occur if not properly disinfected and maintained. After numerous Legionnaire's outbreaks in New York City, New York State began requiring cooling towers to be monitored and then treated for *Legionella pneumophila*; however, EPA currently does not have a registration framework for antimicrobial products with public health claims to reduce *Legionella* in cooling tower water. EPA considers claims to reduce *L. pneumophila* to be public health claims for which the Agency must receive, review, and approve appropriate efficacy data to evaluate such claims. Since it is illegal to use a biocide in a manner not specified on the label and EPA recognizes the public health implications of *L. pneumophila*, it was imperative to develop a method to test efficacy of products against *Legionella* in cooling tower water, so companies can add the claim to their labels. EPA worked with Center for Biocide Chemistries (CBC) and stakeholders to develop a quantitative suspension-based test method to assess the efficacy of biocides against *Legionella*. The method simulates the challenging testing conditions [water hardness, testing temperature, interferences (soil load, additives, etc.)] often found in cooling tower water by including them in the test system. After its development, EPA assessed the method using a 3-phased multi-laboratory collaborative study. In Phase 1, laboratories evaluated one concentration of sodium hypochlorite over three different time points. Phase 1 analyses were used to revise the method. Phases 2 and 3 of the collaborative study assessed low, medium, and high efficacy treatments using non-public health biocides. The method was statistically significantly responsive to the change in treatment efficacy and statistical analysis of the data determined the recommended performance standards. EPA plans to seek public comment on the draft method and a draft guidance framework for registrants seeking claims for antimicrobial products to reduce *L. pneumophila* in cooling tower water.

Evaluating Air Treatment Technology Performance Against Infectious Aerosols

Katherine Ratliff | U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency's (EPA) Homeland Security Research Program has been conducting research to evaluate the efficacy of air cleaning and treatment technologies against infectious bioaerosols. The COVID-19 pandemic has increased interest in these technologies, which can reduce concentrations of airborne pathogens through either inactivation or particle capture, yet it remains difficult to predict the performance of emerging air cleaning technologies in applied settings. Using a large-scale bioaerosol test chamber, EPA has been conducting experiments to evaluate the efficacy of these technologies against the bacteriophage MS2, a surrogate for pathogenic viruses, under conditions that are more representative of real-world environments compared to how they are often tested. This presentation will provide an overview of studies conducted with both far-ultraviolet (far-UVC) emitting and high-efficiency



particulate air filter (HEPA) devices and discuss how changes to test methodologies can significantly impact technology performance, either through calculating log₁₀ reductions or the clean air delivery rate (CADR). These findings highlight the need for standardized test methods for air cleaning technologies in order to optimize their use as part of a layered mitigation strategy to reduce the risk of disease transmission in indoor settings.

Evaluation of an Ionized Hydrogen Peroxide Fogging System for Inactivation of Select Agent Viruses on Laboratory Surfaces at Room-Scale

Lindsay Gabbert | *U.S. Department of Homeland Security*

Aging biocontainment laboratories often require complex and multi-faceted approaches to achieve effective decontamination of large laboratory and vivarium spaces. In support of the development of validated protocols for terminal facility decontamination and decommissioning of the Plum Island Animal Disease Center (PIADC), the SteraMist Environment System, an ionized hydrogen peroxide (iHP) fogging system, was evaluated for its ability to inactivate the small non-enveloped ssRNA Foot-and-mouth-disease virus (FMDV), and the large nucleocytoplasmic DNA African swine fever virus (ASFV) dried on representative laboratory surfaces. Tests were conducted in a ~13,000 ft³ BSL3-Ag vivarium room typically used to house cattle. FMDV and ASFV virus stocks were mixed with a standardized soil load and dried on 1 cm non-porous stainless-steel disks and 1 cm³ porous concrete testing coupons. Stainless steel ribbons containing 6 logs *Geobacillus stearothermophilus* (GST) spores as biological indicators (BIs), and hydrogen peroxide (H₂O₂) chemical indicator strips (CIs), and viruses were magnetically affixed at 36 sampling sites throughout the room. SteraMist Binary Ionization Technology® (BIT™) Solution (7.8% H₂O₂) was fogged at a dose of 0.5mL per ft³ through two Environment Systems and allowed to dwell for a total of 15 minutes followed by a 2-hour room aeration period prior to sample collection. Results demonstrated efficient coverage of iHP throughout the room in, as evidenced by 100% positivity of CIs, and 100% negativity of all GST BIs. FMDV and ASFV were completely inactivated on stainless steel after a 15-minute iHP dwell time in 72/72 samples (n=36/test) (FMDV >5.5LR; ASFV >4.3LR). Additionally, ASFV was completely inactivated on concrete (72/72 negative). Inactivation of FMDV on concrete proved to be more difficult, with initial titrations resulting in very low, but detectable, positivity rates (1/36 positive in Test 1; 5/36 positive in Test 2). After passage three of supernatants initially negative by titration, FMDV sample positivity increased to 8/36 and 21/36 for Tests 1 & 2 respectively. This study provides novel efficacy data on the ability of iHP to inactivate FMDV and ASFV dried on surfaces commonly found in BSL3-Ag containment facilities and laboratory spaces. Additional applied biosafety research is needed to determine effective iHP exposure condition to obtain complete inactivation of FMDV on concrete.

CONCURRENT SESSION 5 – RADIOLOGICAL AGENTS: DECON/SAMPLING & ANALYSIS

Filtration of Radioactive Fallout Particles in Sand Filter Beds

Michael D. Kaminski | *Argonne National Laboratory*

Radioactive fallout could have debilitating effects on drinking water and wastewater systems. At least some drinking water system operators have plans to mitigate the effects of a contaminated water source, but most, if not all, wastewater operators have no such plans. Both types of operators have little or no knowledge of the fate and disposition of radioactive fallout within the individual unit operations of their systems.

We will discuss results of tests to quantify the filtration efficiency of surrogate fallout particles within sand bed systems operating within the range of many drinking water operations. These results will be compared to the Tufenkji and Elimelech, Yao, and Rajagopalan and Tien models for fast filtration bed flow. When combined with our prior modeling of modified filter bed systems, information from this study can help drinking water and



wastewater operators decide how they can mitigate the effects of source water contamination and continue to operate during the emergency phase of a contamination event.

Analysis of Task Performance During Radiological Surveillance by Means of Discrete Event Simulation

Lt. Michael H. Ames | *U.S. Air Force*

The surveillance and detection of radioactive contamination on surfaces and in the environment are commonly investigated by surveyors utilizing portable detection equipment. The availability of Discrete Event Simulation (DES) and Human Performance Modeling (HPM) allows for the analysis of physical and cognitive processes associated with these operations, as well as the effect that external environmental factors have on surveyor performance. This research uses the Improved Performance Research Integration Tool (IMPRINT) to approximate the performance of a radiological detection task informed by the observation of six surveyors. The effects of chemical Individual Protective Equipment (IPE) use is evaluated along with the effects of elevated ambient environmental temperatures. Along with the development of a novel human performance model for the surveillance task, results of this study predict up to a 33% increase in survey completion time when chemical IPE is worn and up to a 50% decrease in surveyor efficiency from the effects of elevated ambient temperatures. Overall, this study represents the novel use of a DES to model the cognitive and physical tasks associated with radiological surveillance activities and the impacts from key physical and environmental stressors.

Days After RDD Recovery – Technology Sub-Group Identified Gaps

Scott A. Hudson | *U.S. Environmental Protection Agency*

A mutual effort between US Dept of Energy, EPA and Israel's Atomic Energy Agency (IAEA) has continued to address what is needed to recover from a radiological dispersal device (RDD) attack. Beginning in July 2022, three subgroups (technology, public health and communications) continue to identify critical gaps in our knowledge or abilities to respond to an RDD event. The technology subgroup has identified 7 existing gaps so far; the presentation will describe details desired to fill these gaps as well as any relevant updates from a planned October 2023 plenary session.

Technology sub-group identified gaps (draft as of July 2023) include: long-term monitoring equipment and procedures for the affected populace; lab capabilities needed to support recovery; waste volume and capacity questions; relocation activity questions; decontamination of wilderness areas.

Accurate Measurement of the Resuspension of Fallout Particles as Input into Urban Plume and Dosimetry Models

Michael Kaminski | *Argonne National Laboratory*

Radioactive plume and dosimetry models use an approach based on the pioneering work of Lynn Anspaugh (LLNL) to define the resuspension of fallout particles from their surface into the breathable air zones given the action of wind. However, it was well recognized during the initial experimental work in the 1960s and 1970s that conditions such as fresh fallout, wind, and mechanical disturbances produced erratic, unpredictable levels of resuspended material (i.e., such conditions that would define the emergency phase of a radioactive release event). Indeed, to develop the first models, experimenters collected data only during quiescent conditions so that well behaved resuspension patterns could be developed and fit to exponential or power law functions.

Designing experiments to account for windy conditions or mechanical disturbances proved difficult. Basic problems with the experimental design such as ensuring sufficient air mixing and spatial positioning of the air monitors created large uncertainties in the computed resuspension data. Merely measuring the resuspended material presented another significant challenge. The gold standard method uses gravimetry to measure the mass collected on filters, but this method requires sufficient dust collection to offset the uncertainties associated with the gravimetric technique. Thus, very long collection times are needed (>1 day) or unrealistic



dust loads that might severely underestimate or overestimate resuspended material in the very early phase following deposition. This could result in reporting severely inaccurate internal dose hazards to those operating in this early phase. Optical scattering devices (Mie scattering) have become popular because of their mobility and low price but they have severe limitations. Moreover, units that are marketed as industrial quality and can measure multiple PM levels simultaneously such as the TSI DustTrak models are not meeting expectations based on laboratory experiments. We conducted laboratory and field tests with low-cost PM monitors and the DustTrak DRX8533 and will discuss the results and recommend paths forward for future tests that strive to produce accurate resuspension data for plume and dosimetry models.



CONCURRENT SESSION 6 – CHEMICAL AGENTS: DECONTAMINATION II

Risk-Based Values for Evaluating Surface Exposure to Chemical Warfare Agents

April Luke | *U.S. Environmental Protection Agency*

Throughout the various phases of a chemical-release incident, risk-based values are critical for decision makers to take actions that are protective of human health. Risk-based values that consider health protection over longer, chronic exposures are particularly important during the consequence management phase as they provide context for evaluating the extent of contamination and the effectiveness of decontamination. For several chemicals, particularly chemical warfare agents (CWAs), it is the contact with contaminated surfaces that presents a hazard; this is why risk-based values developed to account for surface exposure, both direct (dermal) and indirect (hand-to-mouth), are important for preparedness planning and emergency response. In this presentation we apply a surface exposure methodology developed by the U.S. EPA Office of Pesticide Programs along with default exposure parameter inputs (e.g., exposure duration and frequency, body weight, skin transfer, mouthing surface, etc.) used in the U.S. EPA Superfund Program to develop generic surface screening levels for non-porous surfaces in both an occupational and residential setting. This application uses oral reference values and oral cancer slope factors to derive screening levels for non-cancerous and cancerous health effects for a set of CWAs. This is the approach that was developed for use during the response at the World Trade Center (USEPA, 2003) and has been used in other EPA-participated responses (e.g., F/V ESS Pursuit sulfur mustard incident) and exercises. This expansion of the approach fills an identified gap in developing preparedness plans for the remediation of a CWA incident (e.g., assessing decontamination methods and laboratory capabilities) and will provide a starting point for evaluating sampling data for both site characterization and confirmation of decontamination in the case of a real-world event.

SoRite® DECON: A New Decontaminant that Destroys Problematic Psychoactive Drugs

Keri Lestage | *Aseptic Health LLC*

The destruction of psychoactive prescription drugs and their illicit versions have become problematic for the pharmaceutical industry, the Drug Enforcement Administration (DEA) and state law enforcement agencies. Various solutions have been developed by numerous companies to deal with the destruction of psychoactive drugs, but unfortunately a number of the solutions do not work as advertised. Aseptic Health LLC, 1109 Woodland Street, Number 68223, Nashville, TN, 37206, 888-379-3232, <https://aseptichealth.com>, has developed a novel product, SoRite DECON, that truly destroys psychoactive drugs.

The psychoactive drugs that are primarily of concern and the most problematic to destroy and eliminate include methamphetamine, heroin, fentanyl and other opioids. The biggest problem with illicit drugs is the use of fentanyl to mimic the effect of other drugs. Fentanyl is a synthetic opioid that is 100 times more potent than morphine and 50 times more potent than heroin. The potency of fentanyl as an analgesic allows it to be used in minimal amounts to achieve the same effect as other drugs. The most commonly faked drugs are oxycodone, alprazolam and amphetamine where the active ingredient has been replaced by fentanyl. Fake oxycodone pills are the most prevalent. The problem is that most of these fake pills contain fentanyl in excess of 2 mg, which is potentially a toxic dose. When used as a legitimate prescription analgesic, fentanyl is prescribed in doses that range from 0.025-0.1 mg.

Aseptic Health LLC has taken advantage of the chemical structure of psychoactive drugs in developing SoRite DECON. Most psychoactive drugs contain carbon-linked nitrogen or oxygen groups that are highly susceptible to destruction by potent oxidizing agents. SoRite DECON contains a mixture of two potent oxidizing agents that



act synergistically in combination to oxidatively destroy psychoactive drugs. Using liquid chromatography (LC) mass spectrometry (MS) LC/MS/MS analysis Aseptic Health LLC has shown that fentanyl is destroyed in 15 seconds and using hydrogen (1H) nuclear magnetic resonance (NMR) 1H NMR analysis Aseptic Health LLC has shown that fentanyl is destroyed by the oxidation of its internal ring constrained carbon-linked nitrogen groups.

The development of SoRite DECON represents a safer method for the destruction of psychoactive drugs. SoRite DECON does not contain bleach or alcohol. It is mild on the skin, non-caustic and non-reactive.

Decontamination Options for Sensitive Equipment-related Materials Contaminated with a Fourth Generation Agent (FGA)

Jason Sherrieb | *Avarint, LLC*

EPA has conducted prior decontamination research for traditional CWAs, but there is a scientific data gap for decontamination technologies capable of remediating sensitive equipment contaminated with a Fourth Generation Agent (FGA). The purpose of this project was to evaluate the efficacy of commercial-off-the-shelf hydrogen peroxide-based and/or peroxyacetic acid-based decontamination technologies for decontamination of one FGA (A-234) on sensitive equipment materials. The decontaminants investigated include Dahlgren Decon™, Decon PLUS™, and EasyDECON® DF200, all of which use peroxy- species for oxidation and surfactants to enhance transport of the oxidant to the contaminant. These types of decontaminants are generally considered less corrosive than hypochlorite-based oxidants and hence have been proposed to have increased compatibility with sensitive equipment, which are susceptible to corrosive chemicals. The four sensitive materials selected for this study were acrylonitrile butadiene styrene (ABS), silicone, Gorilla Glass®, and high-impact polystyrene (HIPS). These materials are frequently encountered in protective housings for electronics, seals, gaskets, keyboards, and detector equipment. In addition, two types of sensitive equipment (water-resistant calculators and iPhones) were also included in the study. A-234 was applied as liquid droplets to achieve a target contamination density of 2 g/m² to the surface of test coupons, test panels, and full sensitive equipment items. Decontaminants were applied using a semi-automated spray system at a target application volume of 60 to 100 µL/cm². Following the specified decontaminant dwell periods, the test coupons, wipes and/or decontaminant overspray/rinsate were extracted in organic solvent and analyzed using liquid chromatography-tandem mass spectrometry (LC-MS/MS) to quantify the mass of A-234 remaining in the extracts. Results indicate that a combination of physical removal (through measurement of recovered A-234 in the runoff/rinsate) and degradation can lead to high (better than 99%) efficacy. However, one decontaminant only caused physical removal without degradation leaving significant amounts of A-234 in the liquid runoff. No material degradation was observed following application of any of these three decontaminants except for some expected loss of functionality of the electronic equipment.

Mass Casualty Decontamination Research: What's Next?

Kate McCarthy-Barnett | *U.S. Department of Homeland Security*

A large-scale terrorist attack or hazardous material incident would trigger mass-casualty decontamination as part of the standard incident response procedure. For this reason, the US has developed the Primary Response Incident Scene Management (PRISM) Guidance for the initial response phase to a mass casualty CBRN or HazMat events. While the PRISM triple combination approach of dry, ladder pipe system and technical decontamination has been demonstrated to be effective, the guidance is primarily focused on “ambulant” casualties (those who are able to walk and maneuver through decontamination procedures without assistance or accommodations). Currently, there is no federal evidence-based decontamination procedures for at-risk individuals including those with physical, sensory and cognitive disabilities, seniors, chronic health conditions, use service animals or durable medical equipment and others with language barriers.

An international large-scale, multi-agency response exercise to evaluate the effectiveness of the PRISM (“Operation DOWNPOUR”) provided evidence for the first time that current disrobe and decontamination



procedures lack technical evidence and are based on perceived best practices, relying on an assumption that the needs of these casualties can be met by ambulant patient protocols. This research found that the throughput of at-risk individuals was 10 times slower than for ambulant casualties and the delays associated with processing will consequently have a negative impact for all casualties in terms of clinical and operational effectiveness.

In order to effectively respond to a mass casualty chemical incident, communities must be resilient to such catastrophes which requires scientific data to support planning and response. This interactive session will provide participants the forum to review and discuss future mass casualty decontamination research aimed at removing the inequalities and fully integrate an evidence-based response for the safe and effective disrobe and decontamination for all members of the community during a CBRN incident. Reducing the delay between initial exposure to a contaminant and subsequent emergency response actions is considered one of the most important factors for optimizing the number of lives saved.

CONCURRENT SESSION 6 – MULTI-AGENCY COLLABORATIONS

Analysis for Coastal Operational Resiliency (AnCOR) Wide Area Demonstration

Lukas Oudejans | U.S. Environmental Protection Agency

Timothy Boe | U.S. Environmental Protection Agency

Worth Calfee | U.S. Environmental Protection Agency

Michael Pirhalla | U.S. Environmental Protection Agency

Shannon Serre | U.S. Environmental Protection Agency

Bacillus anthracis, the causative agent of inhalation anthrax, is one of the most highly studied biological threat agents. Significant gaps remain related to the remediation of a wide area following such biological release. This presentation describes the planning, execution, data interpretation and outcomes from the Analysis for Coastal Operational Resiliency (AnCOR)'s Wide Area Demonstration (WAD) which was held in May 2022. The AnCOR program is an interagency effort involving the U.S. Environmental Protection Agency (EPA), Department of Homeland Security (DHS) Science and Technology Directorate (S&T), and the United States Coast Guard (USCG). The primary WAD objective was to expand the understanding of the operational effectiveness of decontamination methods and sampling strategies developed in a laboratory by testing them in an outdoor environment. A non-pathogenic organism, *Bacillus atrophaeus* var. *globigii* (Bg), was used as a surrogate.

Samples were collected pre- and post-decontamination for comparison of recovery and assessment of decontamination efficacy of those areas common in an urban environment, also providing sampling personnel real-world experience in collecting samples in full personal protective equipment (PPE). Sampling was also conducted on added materials that are commonly found on a USCG base.

The WAD decontamination assessment utilized high test hypochlorite (HTH) on hard surfaces and peroxyacetic acid (PAA) on vegetation (i.e., grass and trees). The application of decontaminants HTH and PAA was utilized to show the effectiveness against Bg using commercial off-the-shelf (COTS) spray technologies under field conditions. Additionally, designated waste materials were placed inside semipermeable bags made from innovative materials, then fumigated in a roll-off container using chlorine dioxide (ClO₂) gas.

Novel techniques and strategies for data management were used during the WAD including detailing the roles, processes, and technologies for data acquisition, data management for sample collection, and visualization of results from field-collection through analysis and reporting.

The WAD provided opportunities to improve response readiness for mitigating the effects of a release of a biological organism in an outdoor urban environment and to gain real-world experience with decontamination of a biological organism using commercially available equipment.



Laboratory Processing and Sample Analysis of Environmental Sponge Stick and Microvacuum Filter Cassette for the Detection of *Bacillus atrophaeus* subspecies *globigii*

How-Yi Chang | *Centers for Disease Control and Prevention*

Introduction: The goal of the 2022 AnCOR WAD project was to assess the efficacy of decontamination in response to a wide-area outdoor *Bacillus anthracis* contamination. To simulate contamination, EPA disseminated a mixture of water and *Bacillus atrophaeus* subspecies *globigii* (Bg) spores on a mixture of outdoor surfaces. Three Centers for Disease Control and Prevention (CDC) laboratories and four Laboratory Response Network (LRN) laboratories joined EPA in this exercise to process and analyze samples. The results from four of the participating laboratories, two CDC Laboratories (Division of Preparedness and Emerging Infections and Division of Scientific Resources) and two LRN Laboratories (New York State Department of Health Wadsworth Center and Virginia Department of Health) participated in this presentation.

Materials and Methods: Multiple environmental surface samples were collected during background, pre- and post-decontamination. A subset of samples was collected with sponge sticks (n=91) and 37 mm microvacuum filter cassettes (n=67) and were sent to four participating laboratories overnight on cold packs for processing and analysis. The anthrax surrogate Bg spores were first dislodged from the sponge sticks or filter cassettes and sonicated. Each suspension was serially diluted with buffer and spread on tryptic soy agar plates. Samples underwent microfunnel filter-plating to enhance detection of low Bg concentrations. After incubation (35 ± 2 °C) up to 72 hours, plates were examined for growth.

Results and conclusions: For the four laboratories participating in this presentation, Bg were detected in 42.11 % (8 of 19), 87.14 % (61 of 70) and 36.23 % (25 of 69) of the samples collected during background, pre- and post-decontamination, respectively. The data were recorded and shared with collaborators for further analysis. The multi-agency AnCOR exercise had three major impacts. First, results of the exercise provided insights on sample collection and decontamination methods used in the field in the event of a wide-area contamination incident. Collective data from the exercise identified procedural gaps and highlighted room for future improvement. Second, exercise training improved emergency response readiness for personnel at each agency. Finally, CDC and LRN strengthened existing partnerships with EPA. Overall, the exercise strengthened readiness for federal recovery efforts after an incident, which can result in time saved and reduced clean-up costs.

NTAG-R Programme – Enhancing Chemical, Biological, and Radiological Recovery Operations in the UK

Mathieu Thomas Ortega | *UK Department for Environment, Food and Rural Affairs*

Steve Mitchell | *UK Defence Science & Technology Laboratory*

The UK Government's Department for the Environment, Food and Rural Affairs (Defra) is responsible for remediation following a homeland CBR event.

Defra has partnered with the Defence Science and Technology Laboratory (Dstl) to establish a five-year Programme: This is the National Technical Advisory Group for Recovery (NTAG-R).

At the heart of this initiative lies the UK's resolute commitment to robust preparedness, strategic response, and effective recovery in the face of Chemical, Biological, Radiological, and Nuclear (CBRN) incidents.

The NTAG-R has been split into two sub-programmes; these consist of a technical R&D programme and an operational capability programme. They are designed to work together to develop impact. Within the R&D programme, we are developing new technologies and research programmes to fill and mitigate known gaps and those exposed during CBRN incidents or exercises.

The operational capability programme is working to develop the UK operational capability and to expose and prioritise our capability gaps, constantly improving our ability to respond to CBRN incidents.

The key objectives of the NTAG-R are to

- Reduce the time to recover from a small to medium-scale incident (they may ask what our definition of



this is (I would))

- Improve the availability of technologies to remediate to safe levels after an incident.
- Reduce the costs of recovery to the UK Government and the UK economy.

CONCURRENT SESSION 7 – CHEMICAL AGENTS: SAMPLING AND ANALYSIS

Unventilated Monitoring Test (UMT) GPL Monitoring

Nykki Marie Dunaway | *U.S. Army*

Over the last 60 years chemical weapons in the United States have been stored in earthen igloos. As the U.S. destruction facilities continue to safely destroy the chemical weapons stockpile, a process for verifying the safety of the igloos prior to turn-over to the public is being implemented. Unventilated Monitoring Tests (UMT) is the final step in this process. The UMT verifies closure activities have adequately addressed potential agent contamination by air monitoring the igloos' unventilated space to the General Population Limit (GPL) allowing it to be released for unrestricted use as the Depots and other facilities close down. The GPL is a health-based concentration causing no anticipated adverse health effects with repeated exposure for up to 24 hours daily, for up to 70 years. CBARR procedures for conducting the UMT follow a series of steps considering important factors such as dust, temperature, and homogeneity. Lessons-learned have resulted in procedure refinement, improved equipment and cleaning methods, and identification of seasonality impacts in regard to interferences. Future plans, and enhanced capabilities with UMT GPL clearance work, include completion of igloo clearance at Pueblo Chemical Depot in Colorado, potential future work at Blue Grass Army Depot in Kentucky, and additional experience gained for potentially chemical and biological contaminated assets.

Evaluating Sampling Efforts of Fourth Generation Agents from Soil, Water, and Surfaces to Assess Hazard Characterization Capabilities for Contaminated Sites

Stuart Willison | *U.S. Environmental Protection Agency*

The U.S. EPA's Homeland Security Research Program (HSRP) is charged with protecting human health and the environment from accidental and intentional releases of toxic chemicals and other threat agents. Such chemical agents include Fourth Generation Agents (FGAs), which represent a significant homeland security threat. Sample collection procedures of samples from different environmental matrices (e.g., water, soil, and commonly used surface types) contaminated with FGAs require evaluation and development to ensure they can generate quality data for field and remediation operations. Three drinking waters, three soil types, two strippable coatings, and three wipe materials on various surface materials were evaluated with the FGA, A-234. Since low clean up levels might be desirable, samples were contaminated with nanogram (ng) to microgram (µg) levels of the FGA and quantitated with liquid chromatography-tandem mass spectrometry (LC-MS/MS). This work evaluated wipe, water, soil, and strippable coating sample collection methods, including steps for sample collection, sample preservation, and sample preparation prior to analysis to assess for impacts on the accurate quantitation of FGA contamination. Data, including recovery efficiencies, from the tested matrix types described above will be discussed to properly assess sampling efforts for the tested FGA.

Chemical and Biological Threat Dispersion in Urban Environments

Mandeep Viridi | *MIT Lincoln Laboratory*

The Urban Threat Dispersion (UTD) project is part of the Department of Homeland Security (DHS) Science and Technology Directorate's (S&T) efforts to enhance the resiliency of urban areas against chemical and biological agent events. UTD is an airflow and dispersion study that simulated the aerosol release of biological agents in a densely populated urban environment. This study was conducted in New York City (NYC) in October 2021 and involved the release of non-hazardous particulate and inert tracer gas materials. The air and



surface concentrations of the released materials were then measured temporally and spatially across NYC, which involved significant sampling and characterization activities. This seminar will describe the details of the test campaign including release scenarios, simulant selection, measurement plan development, and logistics. This project involved several national lab agencies and the EPA. The results of UTD are helping to validate dispersion models, build CB sensing and response architectures, and enhance decision support tools for critical stakeholders after a CB release event.

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Evaluation of Opioid and Recreational Drugs in Surface Wipe Samples in Remediation Clean Confirmational Analysis of Emergency Response Actions in EPA Regions 7 and 10

James Garcia | CSS, Inc.

Objective: The PHILIS mobile laboratories developed methods for the analysis of opiate and recreational drugs in wipe sample matrices utilizing a triple quadrupole mass spectrometer and GC-time of flight. These methods provide rapid turn-around-time for analytical results while preserving data quality.

Significance: PHILIS's mission is to provide the EPA CBRN CMAD with legally defensible data in the analysis of hazardous and toxic compounds in a rapid turn-around environment. Our sample preparation and analysis methods allow for the detection and quantitation of opiate and recreational drugs for clean confirmation. Providing rapid turnaround of analytical results for facility clearance decisions hastens recovery time during the remediation of toxic contaminated sites. **Procedures and Equipment Utilized:** PHILIS employs UPLC/MS/MS and GC-TOF for opioid and recreational drug analyses. These systems provide low detection limits and faster sample preparation times. UPLC/MS/MS samples were extracted with methanol, shaken and micro-centrifuged for direct injection into the system. Samples prepped for GC-TOF were extracted with methanol using pressurized solvent extraction.

Analytes of interest: methamphetamine, cocaine, heroin, remifentanyl, acetylfentanyl, fentanyl, carfentanyl, sulfentanyl and alfentanyl. **Results Obtained:** PHILIS achieved low ng/wipe levels for wipe samples. PHILIS provided support for the following recent projects. Decontamination of a Car in Kansas City, Region 7. Aug 2022 A car used for smuggling opioids was seized by enforcement agents. PHILIS analyzed wipe samples from surfaces that were previously decontaminated to ensure cleanup levels were met.

Region 10 Motel Opioid Emergency Response. April 2023

A room in a motel was used for the cutting and distribution of fentanyl and methamphetamine. PHILIS analyzed wipe samples from surfaces that were previously decontaminated to ensure cleanup levels were met.

Region 10 Oregon Jail Cell. Jan. 2022

High levels of fentanyl were discovered in the jail cell. PHILIS provided wipe sample kits and a sampling SOP to the sampling team to support the clean confirmational analysis, with clean levels established at 0.1 ug/wipe. PHILIS analyzed wipe samples that exhibited high background contamination.

Region 7 Fentanyl Trailer. Nov. 2021:

State troopers seized a trailer that was loaded with 118 pounds of pure fentanyl powder. The trailer was unloaded and decontaminated.



CONCURRENT SESSION 7 – WATER SECTOR RESILIENCE

Operational Technology Cybersecurity Landscape: Avoiding Contamination Events

Daniel O'Donnell | Booz Allen Hamilton

In March 2018, the U.S. Department of Homeland Security (DHS) and Federal Bureau of Investigation (FBI) issued a joint alert that the Russian government was specifically targeting the water sector and other critical infrastructure sectors as part of a multi-stage intrusion campaign. Since critical infrastructure has been specifically targeted by cyber threat actors, an attack on the OT systems that control physical processes has the potential to: (1) contaminate the drinking water and potentially require the decontamination and disposal of affected water; (2) manipulate sensors to hide or falsely indicate a contamination event or purposely overstate the success of decontamination; (3) interrupt the delivery of water for consumption and other critical community needs (e.g., hospitals); (4) damage plant equipment requiring costly repairs; and (5) risk the safety of site personnel. A cyber-attack does not have to be successful to damage business reputation and customer confidence. In this presentation we will cover the OT Threat Landscape and challenges to securing OT systems in critical infrastructure. One of the significant challenges is that OT systems are not secure by design. These systems have a large lifecycle which leads to a high volume of legacy equipment using insecure protocols or are no longer supported by the manufacturer. Further compounding the issue, hyperconnectivity is another trend that increases the cybersecurity risk as the demand for operational data increases to better support business processes and decision-making. To illustrate OT threats and challenges, the presentation will focus on several case studies such as the 2020 attack against the Israeli Water and the 2000 Maroochy Shire attack in Australia. In the Israeli Water attack, the threat actors attempted to hack into industrial control systems on multiple Israeli water pumping and treatment stations with the intent to raise the level of chlorine to dangerous levels. In addition, the attacker gained initial access via internet accessible OT devices that used default passwords at water pumping and treatment stations. During the presentation, we will provide a review of the key details such as the kill-chain of the attacks as well as lessons learned that could have prevented or mitigated the attacks. We will also highlight Booz Allen's cybersecurity lab, which we use to support clients in addressing challenges in securing OT systems in critical infrastructure.

Water Distribution System Cybersecurity Research at the Water Security Test Bed

Jeffrey Szabo | U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) is the lead federal agency responsible for working with water utilities to protect water systems. Cyber-attacks on critical infrastructure worldwide are on the rise. Documented attempts, successful and unsuccessful, include three attacks against the water sector in the United States in 2021. Presidential directives mandate increased cybersecurity for critical infrastructure sectors in the United States. The Agency has partnered with the Department of Energy (DOE) Idaho National Laboratory, Schneider Electric, Siemens, West Yost, DC Water, and Boise State University to develop the first-of-its-scale water security test bed (WSTB). The WSTB replicates a section of a typical municipal drinking water piping system with roughly 450 feet of pipe, water quality sensors, hydrants, and valves. The purpose of conducting research at the WSTB facility has been to evaluate infrastructure and premise plumbing decontamination technologies, mobile emergency water treatment systems, and now the prevention, mitigation, and quick return-to-service of distribution system Operational Technology (OT) hardware and software compromised by cyber-attacks.

This public, private, and academic partnership is expanding the WSTB to include OT distribution system hardware and software representative of the age, manufacturer, and operating systems typically found in water utilities across the U.S. Water tanks, pumps, level sensors, SCADA, an operator control room are being added to the WSTB to enable testing, training, experiments, and vulnerability verification, the results of which can be used to increase the robustness of water critical infrastructure. Ultimately, this additional infrastructure is designed to accommodate different vendor equipment operating in a common production environments, mirroring configurations currently supporting water utilities in the field. The test bed and the data it generates are expected to increase the cybersecurity posture for water critical infrastructure as well as provide research



and testing space for product and solution maturity, validation of potential services, and the overall safety and security of the U.S. water supply. This presentation will summarize work to date on establishing the test bed and the path forward.

Future Proofing Septic Systems to Sea-Level Rise: Valuing Adaptations and Decision Modelling

Lamis Amer | *University of Miami*

Since 1994, sea levels have risen 4 inches, and are expected to rise an additional 3-6 inches by 2030. This has led to higher groundwater levels, more frequent flooding events, and rainfall, in addition to saltwater intrusion, coastal erosion, etc. These impacts pose risks to the operability of critical infrastructures including decentralized wastewater treatment systems, a.k.a septic system. These systems partially treat wastewater in the septic tank, where solid waste rests in the bottom, and the effluent flows from the tank to a drain field. The drain field then transfers the effluent through to the groundwater through the soil where it undergoes final treatment process. Unsaturated soil conditions and a minimum vertical separation distance between the bottom of the drain field and the groundwater ensure proper functioning of septic systems. With the rising sea levels, these conditions are compromised.

In our research, we first propose a methodology to assess the resilience of septic systems due to future sea levels. In our analysis, we consider the ability of the existing septic systems to resist and adapt to current and future conditions. The developed resilience assessment model encompasses the relationships between the septic systems and other critical infrastructure systems, including freshwater resources and drinking water resources; including drinking water wells, in order to evaluate the extent of impact propagation. Then, a resilience index is proposed and deployed to inform adaptation decision-making. In the proposed adaptation decision-making model several adaptation strategies are considered, and a techno-economic analysis is performed in order to optimize the integrated adaptation portfolio while meeting minimum resilience thresholds. The addressed adaptation strategies include on-site adaptation such as mound (elevated) septic systems, the extension of the regional sewer network, and developing clusters of micro-sewer networks serviced by package plants. We present our methodology on a case study in Miami-Dade County, Florida.

Improved Decisions to Protect Health After Wildfires Attack Utility and Building Plumbing Drinking Water Infrastructure

Andrew J. Whelton | *Purdue University*

Wildfires, floods and other disasters can profoundly impact the safety of drinking water delivered by infrastructure for large and small water systems and building plumbing. When drinking water systems are damaged or contaminated, population displacement and business closures can occur. Impacted households can lose public confidence and experience mental health and financial impacts. For wildfires alone in the U.S., tens of thousands of public water systems and roughly 50% of buildings nationwide are vulnerable. Accidents and intentional events can also prompt acute health risks. Utility professionals and health officials are often looked to after a disaster when drinking water safety is a concern. This presentation will share firsthand lessons from helping water utilities and communities respond to the deadliest, most destructive, and costliest wildfires in recent US history. These include the 2018 Camp Fire, 2021 Marshall Fire, 2020 and 2022 wildfires in Oregon and New Mexico, and 2023 in Maui, Hawai'i. Lessons from responding to and helping communities recover from other chemical spill, backflow incidents, and other disasters will also be shared. Emerging research results regarding water utility and community preparedness, post-disaster decision making, as well as technical issues will be shared such as identifying chemical contamination sources, contamination and decontamination of utility and plumbing infrastructure.



Student Poster Award Ceremony & Closing

Closing Remarks

Gregory Sayles, Center for Environmental Solutions & Emergency Response Director | *U.S. Environmental Protection Agency*

Join us as we announce the winner of the student poster competition!

