

# Office of Hazardous Materials Safety Research, Development & Technology Division: 2023 Forum Summary

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November 28, 2023

**Report to:**

Pipeline and Hazardous Materials Safety Administration

Office of Hazardous Materials Safety

Research, Development & Technology Division (PHH-63)

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## Executive Summary

The U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration's (PHMSA) Office of Hazardous Materials Safety (OHMS) led a virtual public Research, Development & Technology (RD&T) Forum on November 28, 2023. The forum focused on highlighting RD&T's ongoing research projects, current and future research initiatives, program strategies & priorities, and gathering stakeholder input. The objectives of the RD&T Forum were to:

1. Present OHMS RD&T's current research projects along with future research initiatives and program priorities to keep stakeholders informed.
2. Solicit stakeholder input and expertise to identify research gaps, share information, discuss potential opportunities and challenges, identify any HAZMAT (hazardous materials) transport related metrics that would support stakeholders, and discuss insight to stakeholders' perspectives and initiatives.

The forum was composed of one full-day session and opened with remarks from Dr. Robert Hampshire, Deputy Assistant Secretary for Research and Technology, and Mr. William Schoonover, Associate Administrator for the Office of Hazardous Materials. Dr. Yolanda Y. Braxton, Director of Operations System, and the RD&T Program provided an overview of the RD&T program's mission, objectives, research programs, and focus programmatic areas. Following an OHMS RD&T Program introduction, a variety of research project spotlights were presented. The projects were categorized into four sessions: (1) Small Business Innovation Research (SBIR), (2) Rail, (3) Equity, and (4) Batteries.

The SBIR session spotlighted research on "Integrated Radio Frequency Identification (RFID) Trackers for Hazardous Materials Communication" from Newport Sensor Inc.; "Bioremediation for Hazardous Materials Spills" from Aries Science & Technology; "Wearable PPE-Integrated Sensors for First Responders" from Triton Systems; and "Hybrid Leak Detection for Autonomous Vehicles" from Adelphi Technologies.

The Rail projects highlighted ABS Group's research on "Liquefied Natural Gas (LNG) By Rail: Quantitative Risk Assessment (QRA) and Worst-Case Analysis (WCS)," and the Federal Railroad Administration's (FRA) research on "LNG by Rail: DOT 113 Tank Car Testing" from OHMS.

The Equity session presented research conducted on "Environmental Justice and Equity Considerations During the Transport of Hazardous Materials" from the Office of Planning and Analytics (OPA) at PHMSA; and "Equity Measure Research" from the John A. Volpe National Transportation Systems Center.

The Batteries session featured research on "Strategy to De-energize Lithium-Ion Batteries and Sodium-Ion Battery Research" conducted by the Naval Research Laboratory; "Battery Logistics Integrated Safety System (BLISS)" conducted by Energy Storage Safety Products International; and "Portable State-of-Charge Sensors for Lithium Batteries" conducted by TDA Research. For detailed information on these presentations, reference the **Research Project Spotlights** section of this document.

To contact the OHMS RD&T Program, please email [HazMatResearch@dot.gov](mailto:HazMatResearch@dot.gov).

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## Introduction and Overview

### Overview of Forum and Goals

The DOT PHMSA OHMS led a virtual public RD&T Forum on November 28, 2023. The forum focused on highlighting RD&T's ongoing research projects, current and future research initiatives, program strategies & priorities, and gathering stakeholder input.

The goals of the RD&T forum were to:

1. Present OHMS RD&T's current research projects along with future research initiatives and program priorities to keep stakeholders informed.
2. Solicit stakeholder input and expertise to identify research gaps, share information, discuss potential opportunities and challenges, identify any HAZMAT transport-related metrics that would support stakeholders, and discuss insight into stakeholders' perspectives and initiatives.

Twelve research projects were spotlighted regarding integrated RFID trackers for hazardous material communication; bioremediation for hazardous spills; wearable PPE-integrated sensors; hybrid leak detection systems; quantitative risk assessment and worst-case analysis results for LNG transported by rail; DOT 113 tank car testing; environmental justice and equity considerations for transporting hazardous materials; equity measure research; battery research; BLISS and state-of-charge sensors for lithium batteries. For detailed information on each of these presentations, reference the **Research Project Spotlights** section of this document.

This document provides a detailed overview and summary of each portion of the agenda (see below).

### Agenda

November 30, 2023	
<b>9:00 AM – 12:45 PM</b>	<b>Morning Session</b>
	Opening Remarks OHMS RD&T Program Introduction OHMS RD&T Research Project Spotlights (2)
<b>1:40 PM – 4:25 PM</b>	<b>Afternoon Session</b>
	OHMS RD&T Research Project Spotlights (2) OHMS RD&T Future Research Initiatives + Program Priorities Forum Closing Remarks

## Forum

### Opening Remarks

The 2023 RD&T Forum opened with remarks from Dr. Robert Hampshire, Deputy Assistant Secretary for Research and Technology, and Mr. William Schoonover, Associate Administrator for the Office of Hazardous Materials.

Dr. Hampshire highlighted the tremendous role PHMSA plays in providing safety for people and the environment when it comes to transporting hazardous materials. By collaborating with all transportation modes, PHMSA works to develop strategies and enhance safety standards for hazardous materials. PHMSA's mission crosses boundaries across different modes, thus it is critical that research conducted crosses international boundaries to create a global impact. Dr. Hampshire was proud to report that the DOT recently finished its second year of the \$1.2 trillion bi-partisan infrastructure law, with half of the total budget allocated to PHMSA. Dr. Hampshire closed by looking ahead to the future of the Strengthening Mobility and Revolutionizing Transportation (SMART) Grants Program and University Transportation Center (UTC), with \$100 million allocated to 59 projects across 33 states and funding for 35 consortiums (140 universities total), respectively.

Mr. Schoonover spoke about the advancements in the future use of autonomous vehicles and the growth in lithium-ion batteries and their impact on the environment. He noted that further research into these topics will lead to changes that will address and improve climate concerns and concluded by noting that "research and development provide the foundation for making these changes."

### OHMS RD&T Program Introduction

Dr. Yolanda Y. Braxton, Director of Operations System (PHH-60) and the OHMS RD&T Program, introduced the RD&T Program team, which includes Mr. Andrew (Andy) Leyder, Program Analyst, Research, Development, and Technology PHH-63, Mr. Joshua Davis, Physical Scientist, Research, Development, and Technology PHH-63, Mr. Robert (Bob) Starin, Chief, Data, Risk, and Analytics PHH-61, and Ms. Nicole Anderson, Program Analyst, Data, Risk, and Analytics PHH-61. Following team introductions, Dr. Braxton provided an overview of the OHMS RD&T program's mission and objectives. The RD&T program's mission is to improve transportation safety by identifying risk management and mitigation programs and tools, improving packaging technologies and designs, and identifying, developing, and fielding new packaging materials and transportation technologies.

### Research Project Spotlights

The OHMS RD&T program elected to spotlight twelve of its ongoing funded research projects that align with the program and the Department's strategic goals and objectives. A summary of each of the twelve spotlight presentations can be found below. Presentation summaries are based on the order of the forum agenda.

### Harnessing Emerging Technology to Address Today's Hazmat Challenges

#### *Research Project Spotlight: Integrated RFID Trackers for Hazardous Material Communication*

Dr. Maria Feng of Newport Sensors presented the company's research on integrated RFID trackers for hazardous material communication. Dr. Feng presented research that centers around the need for accurate identification and monitoring of hazmat materials while in transit, as inaccurate or damaged physical labels can hinder emergency response and continuous monitoring of hazmat during transport is

crucial. While this is an ongoing SBIR Phase I project, the goal is to develop a prototype of radio identification (RFID) tags that can be placed onto different hazardous material packages. Dr. Feng's presentation detailed the RFID tag's design, how it would have sensors for leak detection and punctures, and the ability to read temperature. The expectation is that the RFID tag will help operators and first responders easily obtain shipping and hazmat information by using a mobile app to read each RFID tag. The tags will also notify operators if there is an issue, such as a leak in certain packages.

Dr. Feng provided an overview of next steps for Phase II of her research, including developing an E-HazID system featuring dual wireless connectivity, conducting a month-long trial in collaboration with interested users, and analyzing collected data to train an Artificial Intelligence (AI) algorithm for safety alerts based on sensor fusion.

#### *Research Project Spotlight: Wearable PPE-Integrated Sensors for First Responders*

Ms. Cole Godzinski of Triton Systems presented the company's research on wearable personal protective equipment (PPE)-integrated sensors for first responders. Wearable PPE-integrated sensors research stems from the fact that HAZMAT incidents occur in chaotic, task-saturated environments, and the current technology is large, handheld, expensive, and difficult to use while wearing PPE and can require difficult training and/or maintenance.

First responders deal with hazardous materials daily across our country. Detecting the risk and exposure to these hazardous materials and toxic gases can be difficult. Existing devices that clip onto PPE or helmets have a risk of falling off or breaking since they are exposed to the environment.

Therefore, the goal of this project is to create a wearable sensor integrated into the PPE of the user. These sensors would have chemical detection for Occupational Safety and Health Administration (OSHA) threshold limits including high sensitivity, durability, and multi-chemical detection; tactile display; and provide situational awareness and enhance communication.

#### *Research Project Spotlight: Bioremediation for Hazardous Material Spills*

Dr. Ram Lalgudi from Aries Science & Technology presented on bioremediation for hazardous material spills. The project's main objective is to improve hazmat spill management by developing a remediation tool that uses organic materials from a biological system. The standard procedure for handling hazardous material spills involves physical containment, removal, and subsequent disposal, often through incineration. This project aims to advance an eco-friendlier approach to cleanup by leveraging specific microbes as absorbents. By adopting this method, the affected area can be restored in an environmentally sustainable manner.

#### *Research Project Spotlight: Hybrid Leak Detection System for Autonomous Vehicles*

Dr. Vladimir Dobrokhotov from Adelphi Technology presented compact broadband leak detectors for autonomous vehicles. Dr. Dobrokhotov provided an overview of conventional gas monitoring and how conventional laboratory gas chromatographs (GCs) are not suitable for monitoring in the field. In contrast, the Adelphi Compact GC has a modular design with interchangeable columns, detectors, and software in addition to having a dynamic range of detectable gases and concentrations. Additionally, Adelphi's GC does not use a PID/FID detector but instead utilizes a solid-state detector. This GC is completely battery-powered and portable for field use.

Furthermore, the Adelphi Compact GC has automated detection and concentration measurements, meaning there is no need for an operator to be involved because sample collection can be automated,

no syringe injection is needed, and it is low cost. Dr. DobrokhotoV shared the GC's architecture and its operating cycle and discussed integrating real-time monitoring with Adelphi's GC. Currently, Adelphi is collaborating with Elroy Air on field testing.

## **Navigating the Hazards: Comprehensive Insights into LNG Rail Transport Risks and Mitigation Strategies**

### *Research Project Spotlight: LNG By Rail: Quantitative Risk Assessment and Worst-Case Analysis*

Mr. Joseph Myers from ABS Group presented on the quantitative risk assessment (QRA) and worst-case analysis (WCA) work conducted as it relates to the transportation of Liquefied Natural Gas (LNG) via rail in response to the related Transportation Research Board (TRB) report's recommendations for additional research. Mr. Myers highlighted PHMSA's ongoing LNG by-rail research and QRA and WCA that were developed. The QRA defines accident scenarios and quantitative risk estimates regarding potential fatalities for the population along LNG by-rail routes that are representative of the US rail network. The QRA used tank car conditions representative of the new DOT 113 tank car in both unit train and manifest train configurations in three different transit operational scenarios. The WCA assessed explosion and fire hazards related to LNG by-rail transport.

ABS Group's research and analysis aims to understand the potential consequences, escalation hazards, and worst-case scenarios in the event of an LNG leak or rail transport incident.

### *Research Project Spotlight: LNG By Rail: FRA DOT 113 Tank Car Testing*

Mr. Robert Starin from OHMS presented on the FRA DOT 113 tank car impact testing. Mr. Starin provided an overview of the side impact test on the DOT 113 tank car that PHMSA and FRA conducted. On May 14, 2022, FRA conducted a full-scale shell impact test (Test 13) of a DOT-113C120W9 tank car filled with liquid nitrogen. The test aimed to evaluate the puncture resistance of the tank car design when subjected to impact. During the test, the outer tank's shell was struck by an about 297,000-pound ram car equipped with a 12-by 12-inch impactor at its mid-height and longitudinally offset about 2.5 feet towards the A-end.

Mr. Starin concluded that the newly constructed DOT-113 tank car demonstrated double the peak force and absorbed energy compared to the legacy DOT-113C120W tank car, indicating improved puncture resistance.

The research team will review the test data, photos, and videos to validate the pre-test finite element (FE) analysis model. The model will be updated to reflect the actual impact conditions and will be used to investigate the puncture resistance of the DOT-113 tank car in real-world service scenarios.

## **Connecting the Dots on Equity: Building Bridges to Inclusion and Justice**

### *Research Project Spotlight: Environmental Justice and Equity Considerations During the Transport of Hazardous Materials*

Ms. Carolyn Nelson from the PHMSA Environmental Policy and Justice Division provided an in-depth overview of environmental justice and equity, how PHMSA and the DOT are using these strategies, and how PHMSA is applying environmental justice and equity through the lens of transporting hazardous material in our communities. Ms. Nelson detailed the concepts of health effects of methane emissions; transportation routing for transporting hazardous materials; developing methodology specifically for identifying equity benefits; and possible cumulative health impacts and how they accumulate over time

and events. Ms. Nelson's office will continue research to develop a PHMSA-specific environmental justice strategy.

#### *Research Project Spotlight: Equity Measure Research*

Mr. Greg Bucci and Mr. Joey Reed from The Volpe Center presented their research on equity measures. The DOT has tasked each operating administration with reducing inequities across the U.S. transportation system and the communities they affect. OHMS has been working with The Volpe Center to develop an equity measurement tool that will review PHMSA's activities and establish a method to track the equity outcomes of these activities. Mr. Bucci and Mr. Reed have completed the initial phase of the project and shared their initial results. The team conducted literature and data reviews and program interviews to determine the proposed measures.

Mr. Bucci and Mr. Reed concluded by sharing that OHMS is well positioned to incorporate practical equity measures into their diverse program areas. Future work will explore program areas further with case studies and will integrate proposed measures into OHMS performance tracking.

#### **Powering the Future: Strategies to Mitigate Risks in Lithium-ion Batteries**

##### *Research Project Spotlight: De-Energize of Lithium-Ion Batteries*

Naval Research Laboratory's (NRL) spotlight began with Dr. Rachel Carter presenting research on de-energizing lithium-ion batteries. As batteries contain energy even at the end of life, effective battery deactivation can help enable ongoing battery recycling efforts. The project's goal is to develop a simple, cost-effective, and universally applicable method(s) to de-energize lithium-ion batteries. Dr. Carter stated that the current processes for deactivation include shredding and saltwater immersion. Shredding is an extremely dangerous, undesirable method, and although saltwater immersion works, it is a slow process that must be monitored closely as salt is corrosive to the electrodes.

Dr. Carter concluded by stating that NRL is developing an alternative deactivation technique using an electrically conductive water-based gel. Deactivation using electronically conductive gel was demonstrated on multiple cell formats and results in a complete elimination of thermal runaway behavior and a significant decrease in gas concentrations with external heating. NRL is focusing future research on improving gel application methods and demonstrations using more relevant battery packs.

##### *Research Project Spotlight: Sodium Ion Batteries*

Dr. Rachel Carter continued the second half of NRL's spotlight by presenting research on sodium-ion battery testing. Understanding the safety risk of the next generation of batteries is a high concern to the broad community. PHMSA has partnered with the NRL to conduct preliminary safety and performance validation on sodium-ion batteries on the market. Dr. Carter provided an overview of the research approach, market research, and accelerating rate calorimetry, and concluded with future directions for this project.

##### *Research Project Spotlight: Battery Logistics Integrated Safety System (BLISS)*

Mr. Ron Butler presented on Energy Storage Safety Products International's battery logistics integrated safety system (BLISS). Mr. Butler provided an overview of the research being conducted, in partnership with PHMSA through SBIR, to create a first-alert packaging system. BLISS's goal is to have packaging that can mitigate the risk of fire and give early detection to carriers and first responders. BLISS dramatically improves safety during battery logistics, aligns with current logistics processes (non-disruptive), and



provides a cost-effective battery packaging system that meets current and future (projected) standards, rules, and guidelines (SRG).

The BLISS features a robust container aligned with current logistics procedures and capable of withstanding the rigors of transport and storage activities. It is designed to control battery fires, relieve pressure buildup, and neutralize flammable and toxic gases through a unique chemical process.

Battery fires continue to be an issue, and the response to battery fires can vary. Mr. Butler detailed that the solution for mitigating battery fires centers around safe battery transport, storage, and charging systems with a full Detection, Notification, Operations, and Communications (DNOC) system.

#### *Research Project Spotlight: Portable State-of-Charge Sensor for Lithium Batteries*

Dr. Josh Biller of TDA Research presented their findings on a portable state-of-charge sensor for lithium batteries. Dr. Biller began by providing an overview of the challenges associated with determining an accurate state of charge on a battery system. The process can be very time-intensive and there are currently no available non-contact and non-destructive evaluation (NDE) techniques for SOC or health monitoring of lithium-ion batteries.

TDA Research has developed prototypes for lab and in-field magnetometry scanning of batteries and/or packs, and they are calibrating magnetic field signatures with electrochemical characteristics.

#### **OHMS RD&T Future Research Initiatives + Program Priorities**

Mr. Andrew Leyder, RD&T Acting Chief, presented the OHMS RD&T Future Research Initiatives + Program Priorities presentation. Mr. Leyder discussed the program's future key priorities and initiatives, which include developing and evaluating new SBIR topics and continuing to work with small businesses through the SBIR program. A second priority is to continue to collaborate with existing federal partners, and to foster new collaboration efforts with other federal partners. The third research initiative and priority is to engage with internal and external subject matter experts (SMEs) on research topics and to identify potential new research projects driven by SMEs.

## **Polling and Audience Engagement**

To gather feedback on research topics and keep the audience engaged in the virtual platform, a series of polling questions were asked following each research project spotlight. The polling questions were a variety of multiple-choice and short-answer questions about the projects, with about two to four questions per research spotlight. Polling questions were also used to gather general feedback on the 2023 RD&T Forum format during the lunch break and following the closing remarks.

In addition to polling questions, participants were also able to use Zoom's Q&A chat feature to provide feedback and ask questions about research spotlights. The Q&A chat was open for the duration of the Forum, with 30 total questions asked. Each of the four research topic spotlights concluded with a Q&A panel discussion. The moderator asked questions from the Q&A chat, sparking great dialogue amongst the panelists. For example, a participant inquired about upcoming rail advancements, and the audience learned that there are advancements on the horizon in hazard communication, including giving hazard first responders' information in a timely manner to mitigate the consequences of rail incidents; hazard communication through technical advances and/or improved regulations is a top priority for the current administration. Other questions asked in the Q&A chat allowed for researchers to explain their projects in further detail to the audience. For example, multiple questions were asked regarding integrated RFID

trackers for hazardous material communication, including how many RFID readers are required for large tank cars and how to gather information about the contents of said tank cars. The audience heard a detailed explanation of how just one RFID reader can be used per tank car and how the data is transmitted to the accompanying mobile application.

To hear the responses to all questions asked throughout the day, please reference the recording for the 2023 RD&T Forum [here](#), using passcode 9aT#&uFn. If you have a content-specific question, reach out directly to the researcher; all contact information for the researchers can be found in the final 2023 RD&T Forum slide deck. To contact the OHMS RD&T Program directly, please email [HazMatResearch@dot.gov](mailto:HazMatResearch@dot.gov).

## Conclusion

The 2023 RD&T Forum adjourned with closing remarks from Dr. Yolanda Y. Braxton, Director of Operations System (PHH-60) and the OHMS RD&T Program. She reiterated that for PHMSA and RD&T's work to be successful, it is critical to foster relationships and engagements with its stakeholders. Dr. Braxton thanked PHMSA leadership for empowering RD&T to rebrand their program, and for fostering innovation in a positive change. The RD&T program values continuous improvement and *“shaping the future of hazardous materials research.”*