

# Office of Hazardous Materials Safety Research, Development & Technology Division: 2022 Forum Summary

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*December 1, 2022*

**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 December 1<sup>st</sup>, 2022. The forum focused on highlighting RD&T's current research projects, current and future research initiatives, program strategies & priorities, and gathering stakeholder input. The objectives of the RD&T Forum were to:

1. Inform stakeholders of OHMS's RD&T current research projects along with future research initiatives and program priorities.
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 to stakeholders' perspectives and initiatives.

The forum was composed of one full-day session and opened with remarks from Tristan Brown, Deputy Administrator for PHMSA and Carey Davis, OHMS Acting Deputy Associate Administrator for Policy and Programs. Yolanda Y. Braxton, Director of Operations System and the RD&T Program and Andrew "Andy" Leyder, RD&T Acting Chief, provided an overview of the RD&T program's mission, objectives, research programs, and focus programmatic areas. Following an OHMS RD&T Program introduction, research project spotlights were presented on Sodium-Ion Battery Research and Strategy to De-energize Damaged/Defective and End-of-Life Lithium Ion Batteries for Safe Shipment from the Naval Research Laboratory; Monitoring of Cylinders and Tanks using Distributed Carbon Nanomaterial Sensing Networks from MCET Technologies; Compact Broadband Leak Detector for Autonomous Vehicles from Adelphi Technologies; and Battery Logistics Integrated Safety System (BLISS) from Energy Storage Safety Products International. For detailed information on these presentations, reference the **Research Project Spotlights** section of this document.

The second portion of the forum focused on obtaining stakeholder input on the direction of current and future research projects through a series of workshops. To facilitate open dialogue amongst participants, breakout sessions were held, in which all participants rotated between the following five topics: (1) safety, (2) equity, (3) climate change & sustainability, (4) emerging technology, and (5) OHMS RD&T future direction and programming. Through the facilitation of these strategic discussions, the RD&T program gathered input on stakeholder initiatives and priorities as well as HAZMAT transport related challenges stakeholders face in their own industry/program of work. **Key takeaways from these sessions focused on the sharing of information between stakeholder groups in terms of applicable research overlap, initiative/program success such as equity programs, and soliciting peer reviews/feedback. Other key areas of interest to note are the prioritization of diversification of decision-making, abiding by specific criteria and standards regarding future research projects, and prioritizing equity, climate change & sustainability efforts to understand the hazardous material footprint specifically in underserved communities.** For detailed information on the outcomes of these breakout sessions, reference the **Working Groups** section of this document.

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## Introduction and Overview

### Overview of Forum and Goals

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 December 1<sup>st</sup>, 2022. The forum focused on highlighting RD&T's current research projects, current and future research initiatives, program strategies & priorities, and gathering stakeholder input.

The goals of the RD&T forum were to:

1. Inform stakeholders of OHMS's RD&T current research projects along with future research initiatives and program priorities.
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.

Four research projects were spotlighted on battery research; the monitoring of cylinders and tanks using distributed carbon nanomaterial sensing networks; compact broadband leak detection for autonomous vehicles; and battery logistics integrated safety system (BLISS). For detailed information on these presentations, reference the **Research Project Spotlights** section of this document.

The afternoon key element of the forum was to obtain stakeholder input on the direction of current and future research projects through a series of five workshops focused on (1) safety, (2) equity, (3) climate change & sustainability, (4) emerging technology, and (5) OHMS RD&T future direction and programming. For detailed information on the outcomes of these breakout sessions, reference the **Working Groups** section of this document.

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

### Agenda

December 1, 2022	
<b>9:00 AM – 12:00 PM</b>	<b>Morning Session</b> Opening Remarks OHMS RD&T Program Introduction OHMS RD&T Research Project Spotlights (4) OHMS RD&T Future Research initiatives + Program Priorities
<b>12:45 PM – 4:00 PM</b>	<b>Afternoon Session</b> Breakout Room Discussions <i>Safety, Equity, Climate Change and Sustainability, Emerging Technology, OHMS RD&amp;T Future Direction and Priorities</i> Breakout Room Closing Remarks Forum Closing Remarks

## Forum

### Opening Remarks

The 2022 RD&T Forum opened with remarks from Tristan Brown, Deputy Administrator for PHMSA, and Carey Davis, OHMS Acting Deputy Associate Administrator for Policy and Programs.

Mr. Brown highlighted economic strength and global competitiveness, calling attention to the impact that supply chain challenges and major disruptions have on PHMSA. The programmatic areas and strategic goals were reviewed noting that without focusing on the core principles of a safe and sustainable system, supply chains will not be resilient to things like a global pandemic. Mr. Brown closed with his hope that mobilizing academia, industry, and government in forums like this, will aid in *“navigating the challenges of a new system of transportation that is now more diverse than the systems that power it.”*

Mr. Davis spoke about the importance of research stating that it provides powerful knowledge and insights that lead to improvements throughout the HAZMAT transport sector, specifically regarding safety. He noted that the field sees the effects of action in real time as the research is being executed. Mr. Davis concluded by reiterating PHMSA’s mission to “protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to our daily lives.”

### OHMS RD&T Program Introduction

Yolanda Y. Braxton, Director of Operations System (PHH-60) and the OHMS RD&T Program, and Andrew “Andy” Leyder, RD&T Acting Chief, presented the OHMS RD&T Program Introduction and the entire RD&T team, which includes Yolanda Y. Braxton, Andy Leyder, Joshua Davis, Erica Wiener, Robert Starin, and Nicole Anderson. Following team introductions, Dr. Braxton and Mr. Leyder provided an overview of the OHMS RD&T program’s mission and objectives. As stated, 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.

Mr. Leyder then discussed RD&T’s four programmatic focus areas which include: 1) risk management & mitigation; 2) emerging technology; 3) packaging integrity; and 4) technical analysis to aid risk assessment. Mr. Leyder discussed each of the focus area’s alignment with DOT’s strategic goals of safety, economic strength & global competitiveness, equity, climate change & sustainability, transformation, and organizational excellence. The presentation concluded with an overview of RD&T’s research programs, which are the Small Business Innovation Research (SBIR) program and the Broad Agency Announcement (BAA) program. Both programs support scientific excellence and technological innovation through the investment of Federal research funds.

### Research Project Spotlights

The OHMS RD&T program elected to spotlight four 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 four spotlight presentations can be found below.

### Research Project Spotlight: Naval Research Laboratory Battery Research

Naval Research Laboratory's (NRL) spotlight began with Dr. Rachel Carter's research on sodium-ion battery testing. Sodium-ion batteries have a lower energy density meaning they have less energetic failures, are capable of fast charging, and suggest a higher degree of safety over lithium-ion batteries. Dr. Carter provided an overview of the research approach, market research, and accelerating rate calorimetry, and concluded with future directions for this project.

Dr. Gordon Waller presented the second half of NRL's spotlight on the deactivation of damaged, defective, and recalled (DDR) 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. Waller stated that saltwater immersion in three solutions was selected as the first potential deactivation method, given a literature survey of existing deactivation methods, which suggested saltwater was a "one size fits all" option. Dr. Waller concluded with next steps and stated that NRL is developing an alternative deactivation technique, which avoids corrosion and hydrogen production.

### Research Project Spotlight: Monitoring of Cylinders and Tanks using Distributed Carbon Nanomaterial Sensing Networks

Dr. Sagar Doshi from Multifunctional Composites and Engineered Textiles (MCET) Technology, presented on the monitoring of tanks and cylinders using carbon nanomaterial sensing networks. Real-time structural integrity monitoring is a scalable and tailorable processing technique that provides real-time monitoring and feedback that can detect strain, impact, and cracks. Dr. Doshi provided an overview of the tasks accomplished during Phase I, which included process optimization of innovative scalable coating technology using a water-based dispersion. Additionally, results were shared from tailoring sensitivity by varying process parameters experiments.

Dr. Doshi continued by sharing next steps, which include testing tanks with MCET sensors and using strain gauge sensors in cyclic pressure tests. There is also ongoing synergistic work on spoolable pipes to detect excessive strains, cracks at joints, ovalization, and debonding. In a SBIR Phase II proposal, key challenges to be aware of will be sub-surface defects, microcracks/matrix cracks, the scale-up of a manufacturing process, electronic connections and robustness, and data collection and analysis.

### Research Project Spotlight: Compact Broadband Leak Detector for Autonomous Vehicles

Dr. Vladimir Dobrokhotov, from Adelphi Technology, presented on 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 is completely 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, automated sample collection, meaning no syringe injection is needed and it is low cost. Dr. Dobrokhotov shared the GC's architecture and its operating cycle, and he discussed integrating real-time monitoring with Adelphi's GC. Currently, Adelphi is collaborating with Elroy Air on system implementation.

## 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). The battery-carry container design allows for mitigation/containment, monitoring/detection, fire/toxic gas control, an audible and visual notification alert, and communications to third parties that a failure is occurring. Mr. Butler showed the BLISS wood battery carry container prototype and walked through its design. Next, Mr. Butler showed the e-charging locker and its potential capabilities including a fire suppression system that is mechanical in nature.

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

Andy 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 working with modal partners on producing a test protocol and testbed to evaluate public safety awareness technologies. The third research initiative and priority are to continue to identify issues involving the transport of defective/damaged lithium-ion batteries, particularly from vehicles. Lastly, another key research initiative and priority for the RD&T program is to research new cylinder designs to support the fast-evolving hydrogen economy.

## Working Groups

During the afternoon portion of the RD&T Forum, attendees were distributed amongst five working groups to participate in interactive discussions focused on 1) safety, 2) equity, 3) climate change & sustainability, 4) emerging technologies, and 5) RD&T future programming. The overarching goals of each session were to address specific topics relating to HAZMAT transport RD&T priorities and to share ideas including industry observations, safety gaps, potential research topics, and future considerations for HAZMAT transport and the RD&T program.

### Working Group: Safety

Safety is an integral part of PHMSA's mission, which is to protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to our daily lives. The RD&T program aims to minimize risks associated with HAZMAT transport through its work and funded projects related to packaging batteries, systems, and emerging technologies. The objectives of this session included: 1) share relevant industry-related initiatives that may apply to resources for RD&T regarding HAZMAT transport safety; 2) discuss critically important safety issues applicable to HAZMAT transport safety; and 3) identify research/emerging gaps observed in the industry that could merit additional research.

With safety at the forefront of RD&T's mission, stakeholders have a vested interest in sharing feedback regarding safety issues that impact their respective areas of work. Discussions revolved around the following topics:

- Transport and disposal of batteries
- Enhanced risk communication to local officials, the public, and transportation planners
- Collection of ozone-depleting gases
- Hydrogenous ammonium transportation
- Criteria for water reactant materials that release toxic gas
- Minimizing human error

- Misclassification of explosives
- Integrity, quality, and testing of various packaging
- Request for more guidance materials, better modeling, data, & risk analyses, and more collaboration with other agencies
- Request for additional transparency of the life cycle of hazmat safety incidents through the collection of various data points and communicating those outcomes in an actionable way to stakeholders

Attendees also offered their insights on specific analytical information that could be beneficial to them or others when it comes to HAZMAT transport. Recommendations were made to enhance incident forms by requesting additional data, flagging contradictory information, and brainstorming ideas to solve the significant underreporting issue.

### Working Group: Equity

For the first time, the DOT has centered “Equity” as a Department-wide strategic goal via its FY 2022 – 2026 Strategic Plan. This is a critical step in institutionalizing equity across the Department’s policies and programs to reduce inequities across transportation systems and the communities they affect. A key priority for the Department is to reduce exposure to hazardous materials and waste, harmful emissions, and noise impacts on disadvantaged and overburdened communities. The RD&T program is working to reduce inequities throughout HAZMAT transport and the communities it affects specifically relating to routing, training, and incidents.

The RD&T program continues to strive to understand how to best meet its equity goal related to the transportation of hazardous materials. As a result, the program highly values its stakeholders’ ideas and input. Key takeaways from discussions included identification of need to:

- Better understand what areas of HAZMAT transport are impacted and how
- Benchmark equity progress accomplished by other agencies, divisions, and areas of priority
- Understand how to bridge the gap between disparate communities and the HAZMAT industry
- Identify how to leverage current and emerging technologies to better understand and serve underserved at-risk communities
- Coordinate with community planning organizations to understand the hazardous material footprint
- Establish map-based risk modeling that considers equitability in its development
- Identify high-risk areas and better organize prevention and planning activities
- Optimize communication strategies with underserved communities to ensure the clear transference of communication and messaging

While valuable feedback and ideas were received from the Equity working groups, soliciting stakeholder input proved challenging. This further illustrates the importance of equity, identifying the obstacles that must be overcome, and the need to engage in meaningful conversations that will contribute to addressing equitability issues within HAZMAT transport industries. PHMSA and the RD&T team will continue to identify ways to solicit feedback and foster open dialogue on this topic.



### Working Group: Climate Change and Sustainability

Sustainable initiatives are vital to the success of HAZMAT transport. The RD&T program remains committed to projects that minimize and/or mitigate potential harm to the environment and communities by ensuring a transportation role in the solution to reduce emissions and pollution. As stated in the breakout discussions, two key priorities for the Department include 1) reducing exposure to noise pollution, criteria pollutants, and other transportation impacts on communities and ecosystems; and 2) supporting innovative programs, policies, and projects to reduce environmental impacts associated with freight movements.

The diverse conversations and ideas discussed in the climate change & sustainability working groups demonstrate the vast possibilities of research. Participating stakeholders shared multiple ideas related to the sustainable transport of hazardous materials, including recommendations for:

- Development of advanced catalytic materials that can process explosive and toxic gases
- Building a secure network that would inform the public and stakeholders about the movement of hazardous materials through jurisdictions
- Keeping up to date with regulations as it is uncertain what future chemicals and in what quantities they will be transported
- Decarbonization of transport systems
- Securing relevant data applicable to hazard type risk models to support hazmat routing, which works to minimize risk and exposure to the impacts of climate change
- Reducing the long travel times and distances of batteries between facilities and customers and therefore reducing the risk of incidents
- Sustainable end-of-life battery extension and recycling; a shift towards cleaner energy sources and prioritizing hydrogen strategy
- Collection of o-zone depleting cylinders
- Electronic shipping documents to promote a paperless society
- Sustainable packaging
- Waste reduction during loading and unloading processes
- Accurate and reliable measurement of environmental risk
- Concern over a sustainable workforce and a lack of truck drivers in relation to the transport of hazardous materials

An important discussion was also held to prioritize the diversification of decision-making, given that in many cases, there is only a single perspective heard that does not account for more groups. To achieve sustainability, buy-in must take place from multiple, and diverse groups. Additionally, the groups discussed the importance of collaborating with industry partners to support forecasting industry trends and identifying materials and demands that would be able to assist in the identification of existing regulatory gaps.

### Working Group: Emerging Technologies

Emerging Technology is one of four of the RD&T program's main programmatic focus areas. As the U.S. economy expands and diversifies with new energy sources, transport systems and packaging technologies, RD&T research is designed to identify and analyze emerging materials, processes, and packaging technologies as well as assess their potential risks or benefits to the existing HAZMAT

transport network. The objectives of this breakout session were to: 1) share relevant industry-related initiatives that may be applicable resources for RD&T regarding emerging technologies and HAZMAT transport, and 2) discuss and identify research and emerging gaps observed in industry that could merit additional research.

Several emerging technologies related to HAZMAT transport were discussed throughout the working sessions. These technologies included:

- New formulations of ammonium nitrate emulsions
- Per- and polyfluoroalkyl substances (PFAS) pollutant reduction during incidents
- Potential increase in carbon dioxide movements as a product of carbon capture
- Increases in larger lithium battery EOL movements and secondary markets for these
- Advanced composite materials for means of containment (MOC)
- Nanotechnologies
- Drone transport of dangerous goods to remote communities
- Fiber reinforced plastics bulk energy storage transport solutions
- AI/ML applications
- Cybersecurity
- Hydrogen
- Centralized battery stations
- Digital twinning specifically for hydrogen vehicles

Common themes were carried out throughout each emerging technology working session, specifically regarding key considerations for implementing emerging technology research. Attendees reviewed specific criteria and standards that all emerging technology should adhere to before receiving funding approval. These criteria themes included appropriately distributing research dollars between agencies, open lines of communication between research groups and agencies specifically in addressing auto-enrollment and notification of open contracts and handling proprietary emerging technology ethically and without favoritism.

In conclusion, the working groups reached a consensus that emerging technology research should follow a set of standards set forth by trusted agencies, meet regulatory compliance, and should align with a set of questions before receiving funding approval. Questions could include, “Is the emerging technology manufacturable? Maintainable? Can it be integrated with current technology/equipment?”

#### **Working Group: RD&T Future Programming**

The OHMS RD&T program is analyzing the best path forward to meet stakeholder needs, advance, and promote relevant research that will drive safety, transformation, equity, climate change & sustainability, and global competitiveness. The purpose of this breakout session was to engage and hear from stakeholders on how the program can best serve its stakeholders. Key points considered during the session included 1) priority and RD&T program alignment with DOT; 2) potential stakeholders applicable to RD&T; and 3) applicable data sources.

A consensus amongst the different working groups was reached regarding the emergence of two of RD&T’s main programmatic areas: Risk Management & Mitigation and Technical Analysis to Aid Risk Assessment. To replace the fourth programmatic area, it was recommended to include supply chain

safety and efficiency to investigate how to transport safety through supply chain efficiency. Participants recommended:

- Continued research related to lowering the impact of accidents on lithium-ion batteries
- Better understanding of emergency response needs related to hydrogen-fueled vehicles
- Development of a reliable information and identification system for the possible threats of moving hazardous chemicals that are being transported through certain jurisdictions
- Establishment of a peer review group amongst industry government stakeholders to avoid future research duplication and to provide valuable insights and input into the selection of research topics
- Follow-up symposiums to provide progress updates on research projects, and for stakeholders to submit future research topics

## Conclusion

Following the conclusion of the five breakout room sessions, each breakout room facilitator provided a brief overview and summary of key takeaways and ideas that were discussed during the sessions. Reference the working group sections above in this document to read the session summaries.

The 2022 RD&T Forum adjourned with closing remarks from 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. The RD&T program values continuous improvement and *"being better tomorrow than we are today."*