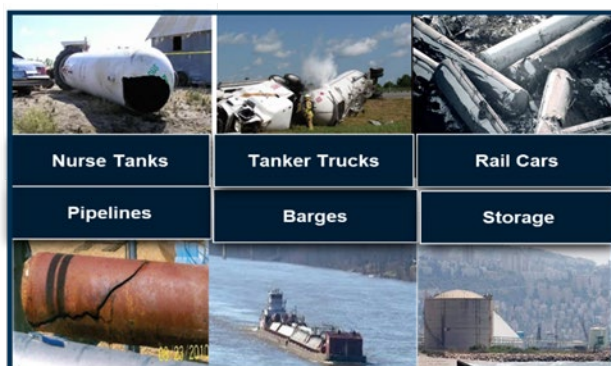


### NATIONAL HAZARD MITIGATION AND CONSEQUENCE ASSESSMENT OF AMMONIA RELEASES

The U.S. produces, exports, imports, and consumes millions of tons of anhydrous ammonia annually. The available volume of ammonia is projected to triple by 2030, significantly increasing the potential terrorism threat and the risk of a large-scale ammonia release. Assessing the consequences of devastating ammonia release incidents from transportation containers revealed critical knowledge gaps.



*Anhydrous ammonia release hazards create challenges for source terms in modeling predictions*

To address these gaps, the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) is sponsoring the Jack Rabbit (JR) III program, which involves conducting both small- and large-scale experiments in collaboration with government, industry, academia, and international partners. The purpose of JR III is to experimentally characterize the toxic inhalation hazard associated with ammonia releases by identifying behavioral anomalies in chemical plumes within a controlled environment. This will be followed by incremental releases of anhydrous ammonia to predict its behavior during different seasons and times of day. These experiments are designed to investigate ammonia releases under real-world operational conditions, enabling the development of pertinent emergency response procedures and technologies.

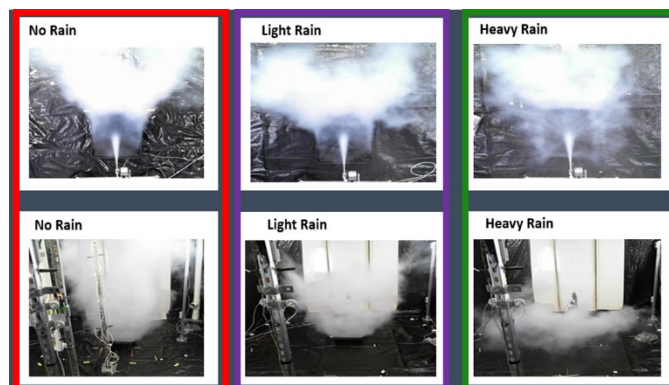
### JR III PROJECT IMPACT

- Deterring the potential use of toxic industrial chemicals as weapons of mass destruction

- Increasing the efficiency and effectiveness of emergency response
- Enhancing security against chemical terrorism and threats at U.S. ports
- Developing data-driven mitigation strategies to reduce the impact on affected populations and infrastructure
- Enhanced preparedness in the event of an accidental or intentional release of ammonia
- Maximizing the utilization of emergency common operating platforms through augmented concepts of operation

### ACCOMPLISHMENTS

- Completed static environment chamber testing and collected empirical data, characterizing the ammonia plume



*The first-time visible ammonia plume behaviors have been captured under controlled environments, comparing ammonia plumes under dry conditions, light rain, and heavy rain at ambient temperature (22°C).*

- Conducted small-scale outdoor test releases of ammonia through the Technology Experimentation & Characterization Field Trials
- Assisted in ammonia mitigation efforts including water spray curtains and Tarp & Cover tactics in collaboration with The Fertilizer Industry (TFI), Tanner Industries, and Transportation Community Awareness and Emergency Response (TRANSCAER®) for Louisiana local responders at the Joint Emergency Services Training Center



*Demonstration of a downwind dispersion hazard mitigation tactic during live ammonia release training at Joint Emergency Services Training Center, Louisiana, in 2024.*

- Established a Cooperative Research and Development Agreement with CF Industries and the Ammonia Safety & Training Institute
- Developed human ammonia inhalation toxicity estimates from sub-lethal to lethal endpoints (suitable for casualty estimation) for the general population, which are crucial for the hazard assessment of ammonia releases

## RESEARCH OBJECTIVES

- Data-driven modeling advancement: provide the summary of results from the JR III international model inter-comparison exercise on Desert Tortoise and Fladis
- Emergency response-centric framework: assist first responders with adequate modeling tools for ammonia incidents involving a nurse tank
- Evidence-based and informed consequence assessments: updated acute ammonia vapor toxicity estimates in humans for the public and first responders

## COLLABORATION PARTNERS

S&T CSAC has partnered with the U.S. Department of Defense's Defense Threat Reduction Agency, Transport Canada, and the Defence Research and Development Canada to conduct multi-phase JR III experiments to advance modeling capabilities. Other collaborative participants include CF Industries, Tanner Industries, TRANSCAER®, TFI, Air Products, Ammonia Safety & Training Institute, the United Kingdom Health and Safety Executive, DHS Countering Weapons of Mass Destruction Office, first responders, Federal Law Enforcement Training Center, Cyber and Infrastructure

Security Agency, and federal, state, and local emergency management agencies to implement predictive modeling tools and enhance the efficacy of emergency management and response protocols. The JR III Scientific Advisory Group has been established as the overarching body for project governance, supported by technical working groups for Data Quality, Modeling (Waterborne and Atmospheric Dispersion and Transport), Deposition and Surface Chemical Reactivity, Source Terms, Instrumentation, Emergency Responders, and Health and Human Effects.

## FUTURE WORK

- Investigate and research historical ammonia release incidents, both domestic and abroad
- Obtain datasets and fill targeted data gaps to provide insights into how operationally relevant meteorological conditions such as hot, cold, humid, and rainy environments affect ammonia plume behavior
- Conduct a pilot-scale outdoor anhydrous ammonia release and construct a transportable dissemination vessel that can support the planning of large-scale outdoor releases for computational modeling prediction improvements for emergency response applications
- Collaboratively initiate dynamic chamber studies of the effects of soil and vegetation on the deposition and evaporation of ammonia
- Plan large-scale outdoor releases in non-desert environments for modeling validation in future years