IV.F.6 Planned Work under New DOE Hydrogen Storage Award for Storage Safety Testing and Analysis

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Subcontractors:
- Kidde-Fenwal, Combustion Research Center, Holliston, MA
- GWS Solutions of Tolland, Tolland, CT

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Project End Date: June 1, 2010

Objectives

- Provide improved definition of the DOE safety target and its link to material reactivity measurements to guide research and selection of storage materials.
- Develop qualitative and quantitative risk analysis tools to evaluate safety risks for solid and liquid hydride-based systems before and after mitigation methods.
- Perform dust explosion tests for metal hydride, chemical hydride and absorbent materials.
- Characterize chemical reactions for material exposures associated with both risk events and mitigation approaches using time resolved X-ray diffraction.
- Assess the trade-offs between residual risk after mitigation and the system weight and volume as well as reaction rates.

Technical Barriers

This project addresses the following technical barriers from the Hydrogen Storage section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

(F) Codes and Standards (Safety assessment for storage materials)

(A) System Weight and Volume

(E) Charging/Discharging Rates

Technical Targets

The key technical target of this project is environmental health and safety, having a focus on the safety sub-target with some considerations for toxicity. Safety is one of the most significant issues affecting consumer acceptance and adoption of hydrogen-fueled vehicles. From the DOE Hydrogen Program project The DOE Baseline Knowledge Survey: Measuring H2IQ, results from general public opinions indicate that "When selecting a fuel supply, the public considered safety as the most important factor ...". The technical target for safety is currently specified generally as "meets or exceeds applicable standards." For metal hydride, chemical hydride and absorbent materials and systems, however, no such standards exist today. Furthermore, standards currently under development will be high-level in scope, being primarily focused on systems and will not provide adequate guidance to help evaluate new materials and assist in selecting viable candidates. As part of this effort, trade-offs will be evaluated between the residual risk after mitigation and the two performance targets: system weight and volume, and charging/discharging rates. The current project, in collaboration with projects at Savannah River National Laboratory (SRNL) and Sandia National Laboratories (SNL), will fill a technical gap in the current Hydrogen Storage Program by developing methods of assessing risks before and after applying mitigation methods to provide improved definition of the safety target for materials-based storage systems.

Approach

The project will have five distinct elements to perform the range of studies needed, spanning detailed reaction measurements, standardized materials tests, development of mitigation methods, prototype demonstration, and compilation of this data into a formal risk analysis framework. A sketch illustrating the central role of the risk analysis framework, linking the more detailed material measurements and modeling with the higher level DOE safety target and codes and

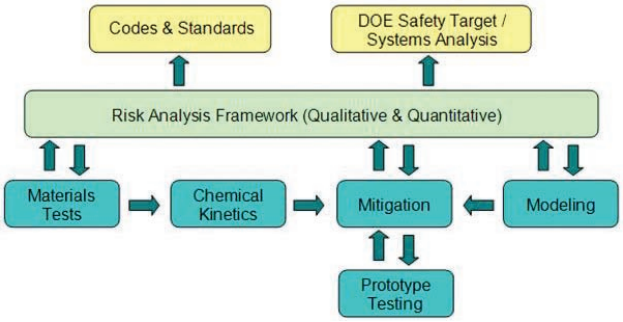

FIGURE 1. Relationship between Project Elements and High Level Objectives

standards is shown in Figure 1. Additional data from the SRNL and SNL DOE projects as well as from international partners in an associated International Partnership for the Hydrogen Economy (IPHE) project will be incorporated into the risk analysis. The primary five approach elements are described in more detail in the following:

- **Risk Analysis:** Formal risk analysis methods will be employed and customized to develop a tool which provides an increasingly quantitative description of the risks of materials and systems throughout the project before and after the use of mitigation methods.
- **Standardized Materials Testing:** A set of standard materials tests will be performed on storage materials to quantify their reactivity under conditions of potential risk scenarios.
- **Chemical Reaction Kinetics Testing and Diagnostic Modeling:** Fundamental studies will be performed to evaluate the chemical kinetics of material reactions with oxygen, water and various fluids using time resolved X-ray diffraction and other facilities to support risk mitigation development.
- **Risk Mitigation:** Concepts to reduce the dominant risks will be devised and investigated both at the material and system levels. The impact on system performance will also be determined.
- **Prototype System Testing:** Subscale prototype tests will be performed to evaluate the response for larger quantities of hydride and the effectiveness of the risk mitigation methods.