

Exceptional service in the national interest



Twitter: @SandiaEnergy



Website: energy.sandia.gov



Sandia National Laboratories Hydrogen and Fuel Cell Technical Advisory Committee Meeting, April 6–7, 2016

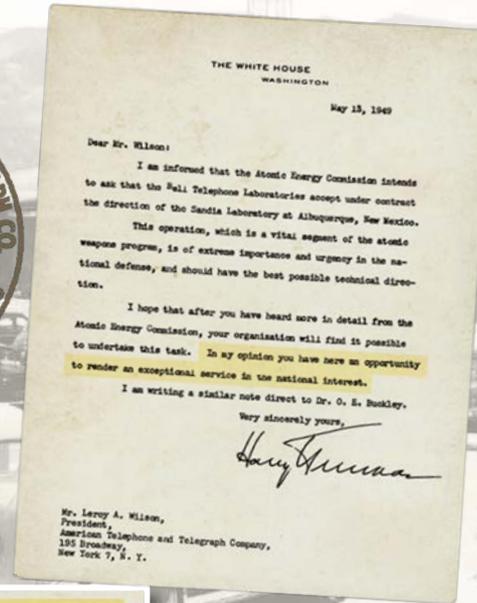
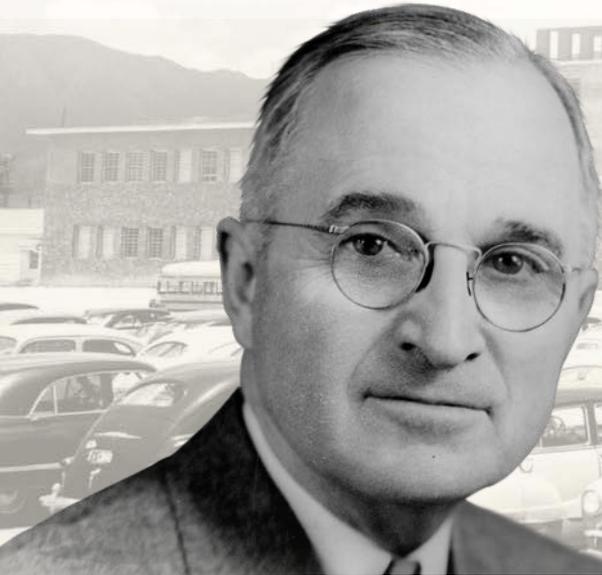
SAND2016-2931 PE



Marianne C. Walck, Ph.D.
Vice President, California Laboratory
Vice President, Energy & Climate Program

Sandia's History

Exceptional service in the national interest



July 1945: Los Alamos creates Z Division

November 1, 1949: Sandia Laboratory established

1952: University of California Radiation Laboratory at Livermore (now LLNL) established

March 8, 1956: Sandia officially establishes a second laboratory at the Livermore site

to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.



Sandia Operates in Many Locations

Albuquerque, New Mexico



Livermore, California



Kauai, Hawaii



*Waste Isolation Pilot Plant,
Carlsbad, New Mexico*

*Pantex Plant,
Amarillo, Texas*



*Tonopah,
Nevada*

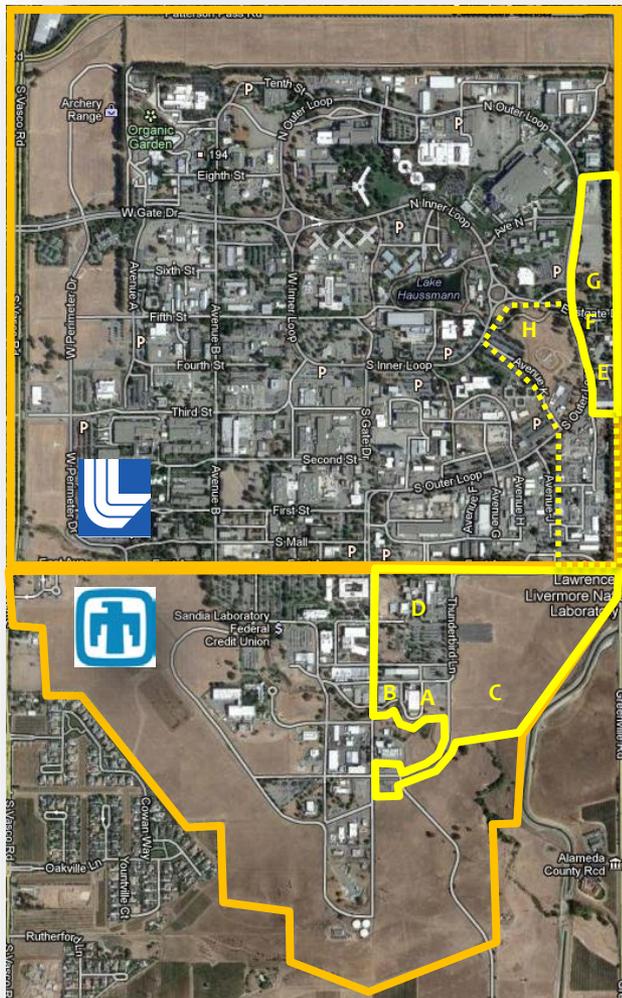
Sandia California Laboratory is a Strategic Asset



- National Laboratory Partnerships:
 - Lawrence Livermore
 - Lawrence Berkeley
- University Collaborations-provide access to world-class minds and unique facilities
- International Partnerships
- Industry Collaborations
- State of California – leadership in energy policy
LVOC enables partnerships that benefit the entire breadth of Sandia's mission space

Livermore Valley Open Campus (LVOC)

Enhance collaborations between the external world and the Labs



South campus
(SNL Facilities)

North Campus
(LLNL Facilities)

**A. Cybersecurity
Technology
Research
Laboratory**



**B. Bio-tech
Facility**



**C. Clean Energy
Demonstration
Field**



**D. Combustion
Research
Facility**



**E. High
Performance
Computing
Innovation
Center**



**F. Discovery
Center**



**G. Hertz
Hall
Complex**



**H. HPCIC
leverages
proximity to
future
Advanced
Computing
Complex**



Over 250,000 square feet of office and lab space

Sandia's Energy Program

Energy Research



Chemical, Geological, Biological, Materials, Computational, and Nano Sciences

Nuclear Energy & Fuel Cycle

Commercial Nuclear Power Generation, Nuclear Energy Safety & Security



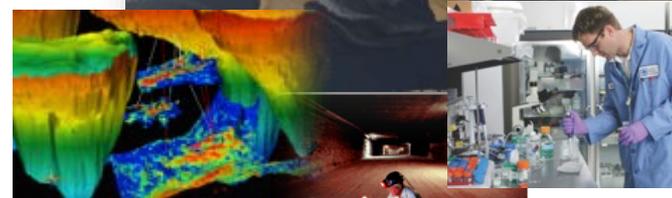
Renewable Systems & Energy Infrastructure

Renewable Energy, Energy Efficiency, and Grid Modernization



Climate & Engineered Earth Systems

Measurement & Modeling, Energy & Water, Fossil Energy, Biofuels, DOE Managed Nuclear Waste



Transportation Energy & Systems

Vehicle Technologies, Biomass, Fuel Cells & Hydrogen Technology



Sandia's Hydrogen Program

Hydrogen Production



Develop concentrated solar power for large-scale, renewable production of hydrogen

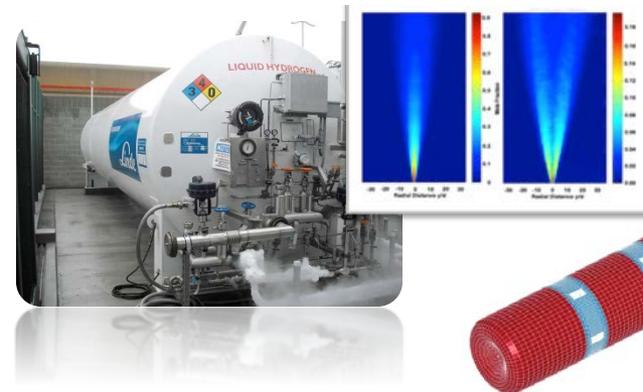
Hydrogen Delivery

Identify pathways for reducing cost of steel hydrogen pipelines without compromising reliability and integrity



Safety, Codes and Standards

Facilitate safe deployment of hydrogen technologies with science-based codes and standards



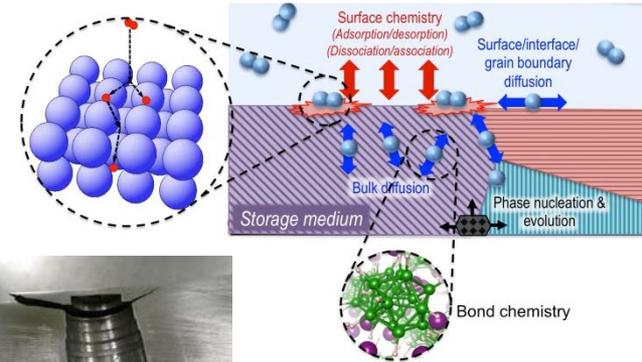
Systems Engineering

Demonstrate innovative engineering solutions to harness clean energy technologies



Hydrogen Storage

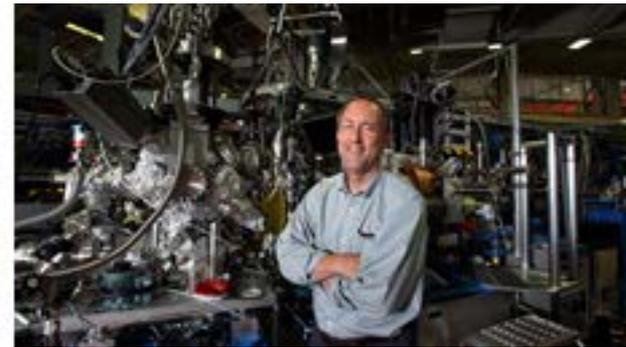
Provide fundamental understanding of the phenomena limiting solid-state hydrogen interactions



Fuel Cells

Develop new membrane systems for enhanced electrochemical performance





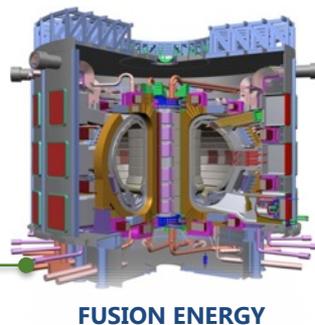
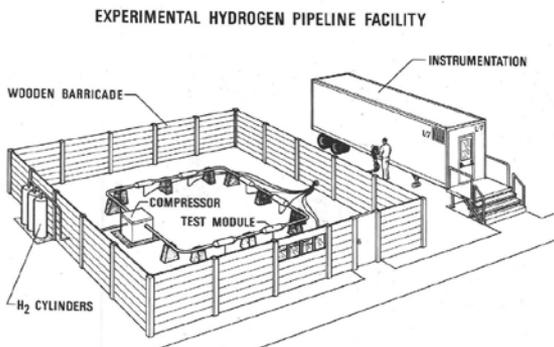
FUEL CELLS TECHNOLOGY OFFICE (FCTO) and

SANDIA'S HYDROGEN CAPABILITIES

Chris San Marchi
Hydrogen Program Manager
Distinguished Member of the Technical Staff

History of Hydrogen Sciences at Sandia

Core mission to support the nuclear deterrent
Enabling science and engineering for energy programs



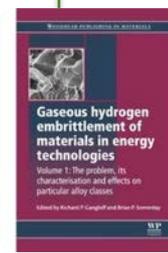
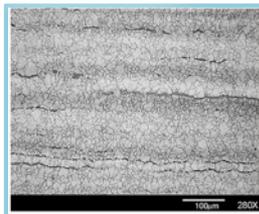
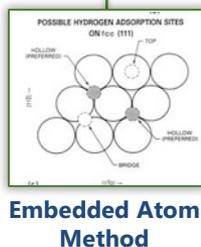
Lift-Truck Lifecycle Requirements



H2 Infrastructure Partnerships



1960 1970 1980 1990 2000 2004 2008 2012 2016



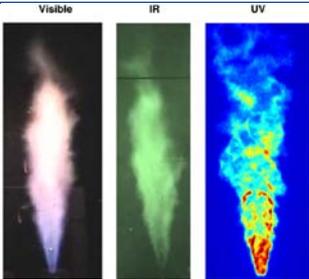
Core Hydrogen Capabilities

- Hydrogen behavior and risk evaluation (QRA)
 - Turbulent Combustion Laboratory
- Compatibility of materials in high-pressure hydrogen
 - Hydrogen Effects on Materials Laboratory (HEML)
- Solar thermochemical hydrogen (STCH) production
 - National Solar Thermal Test Facility (NSTTF)
- Storage materials discovery and development
 - Hydrogen Materials – Advanced Research Consortium
- Membrane synthesis and development
- Infrastructure scenario and technoeconomic analysis
- Solid-state hydrogen storage system engineering
- Hydrogen Fueling Infrastructure Research and Station Technology
 - Hydrogen Station Equipment Performance (HyStEP) device



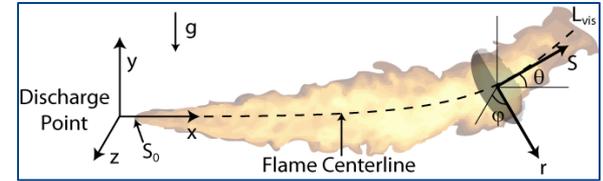
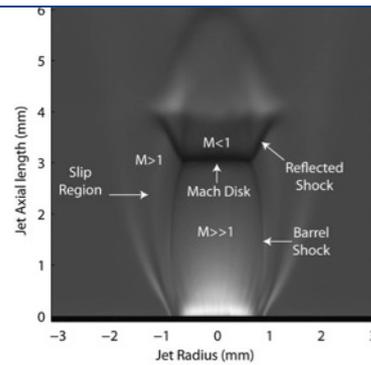
Hydrogen Science is Key to Developing Predictive Engineering Tools for Safety, Codes and Standards

Radiative properties of H2 flames quantified

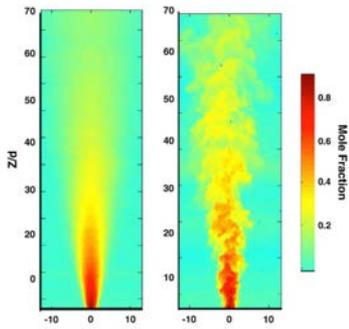


Barrier walls for risk reduction

Ignition of under-expanded H2 jets

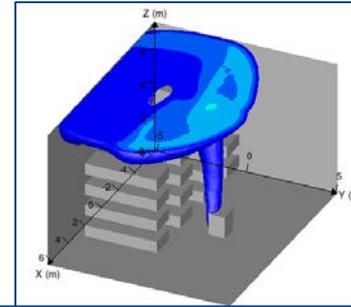
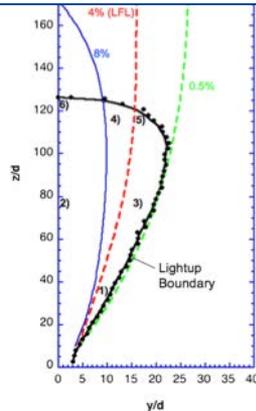


Buoyant jet flame model with multi-source radiation



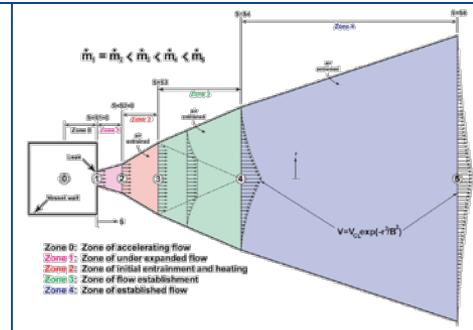
Advanced laser diagnostics applied to turbulent H2 combustion

Ignition limits of turbulent H2 flows



Experiment and simulation of indoor H2 releases

Laboratory-scale characterization of LH2 plumes and jets



Making Science Accessible through Integrated Tools

risk

Develop integrated methods and algorithms

for enabling consistent, logical and defensible QRA

application

Apply quantitative risk assessment techniques

in real hydrogen infrastructure and emerging technology

behavior

Develop and validate scientific models

to accurately predict hazards and harm from liquid releases, flames, etc.



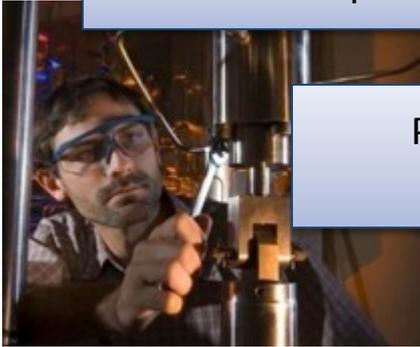
hyram.sandia.gov



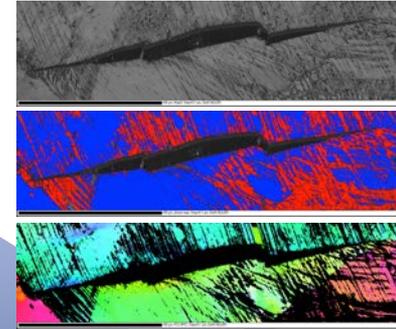
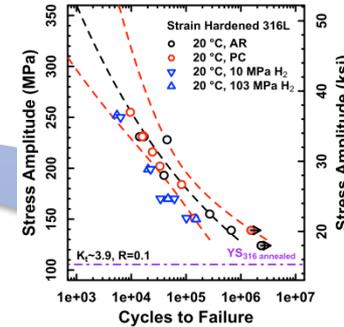
Official public release:
April 26th webinar

International Leadership in Materials Compatibility Enables Innovation of Hydrogen Technologies

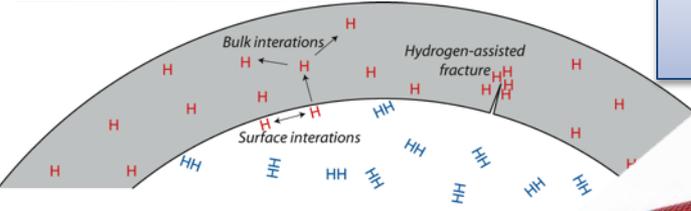
Develop test methods



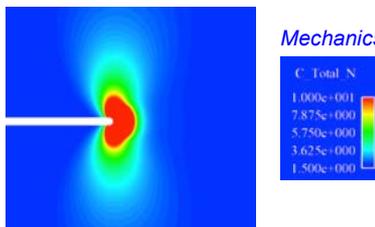
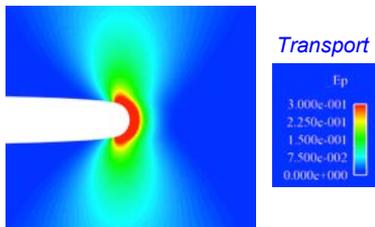
Performance-based testing (compatibility)



Understanding physics of hydrogen embrittlement



Predictive models



System validation (suitability)



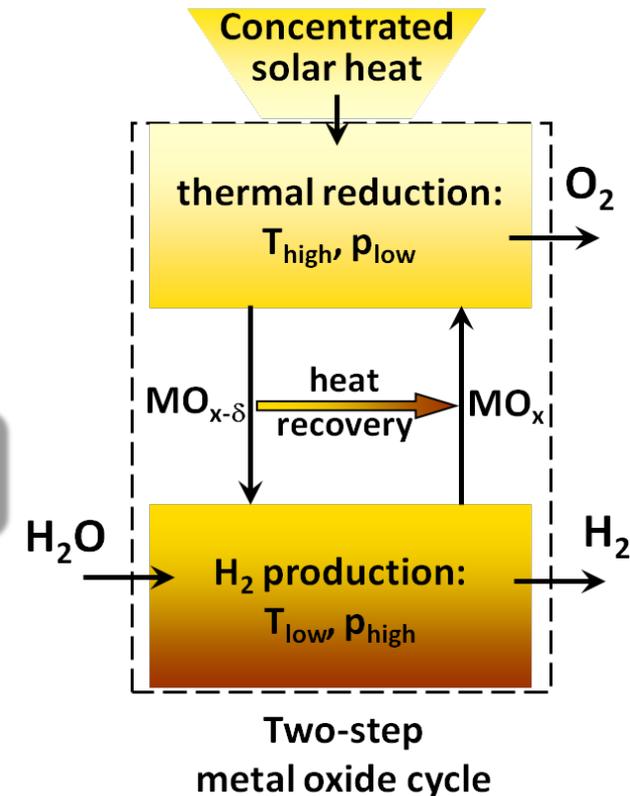
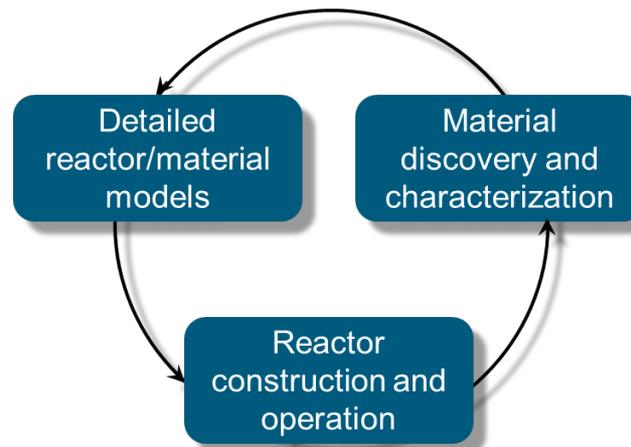
Large-Scale Renewable Hydrogen Production using Solar Power Leads to a Sustainable Energy Future

Two-step thermochemical water-splitting cycle



MW scale concentrating solar power facilities provide heat for

1. Metal oxide reduction
2. Oxidation with water *producing hydrogen*



The challenge is to develop efficient and scalable solar-powered reactors up to 100,000 kg/day

Early Hydrogen Market Demonstrations

Hydrogen Fuel Cell Mobile Light Tower

- Zero emissions
- Quiet alternative to mobile diesel power



Hydrogen Fuel Cell Generator for Maritime/Ports

- Quiet deployable power
- Containerized, clean power

Zero Emission Hydrogen Passenger Ferry (*study*)

- Green transportation over water
- Multi-use hydrogen station



Sandia's Hydrogen & Fuel Cells Program

Providing the science and engineering to accelerate the deployment of clean and efficient hydrogen and fuel cell technologies



Commercial hydrogen systems today are safer and less costly due to Sandia's scientific and technical leadership