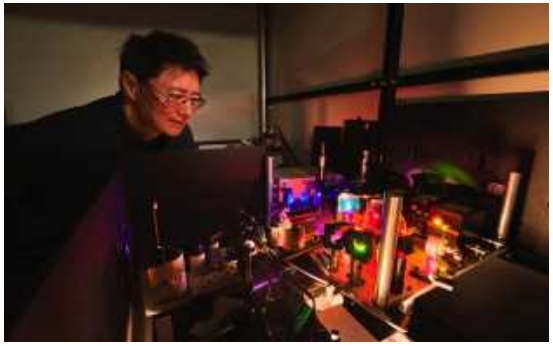
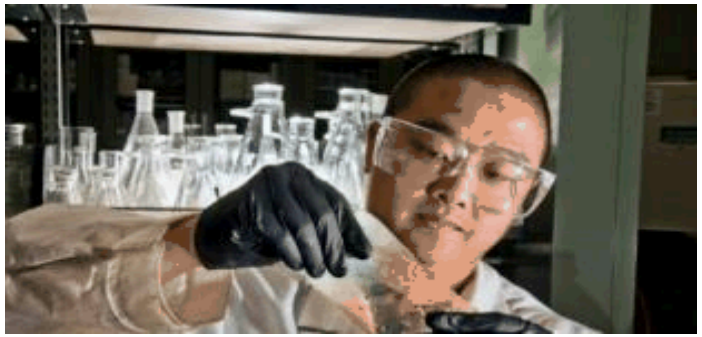
SAND2015-10763C

*Exceptional service in the national interest*

Sandia National Laboratories





# GENI Planning – A Sandia Perspective

***Rob Forrest***

***Workshop on GENI***

***December 14-15, Daejeon***

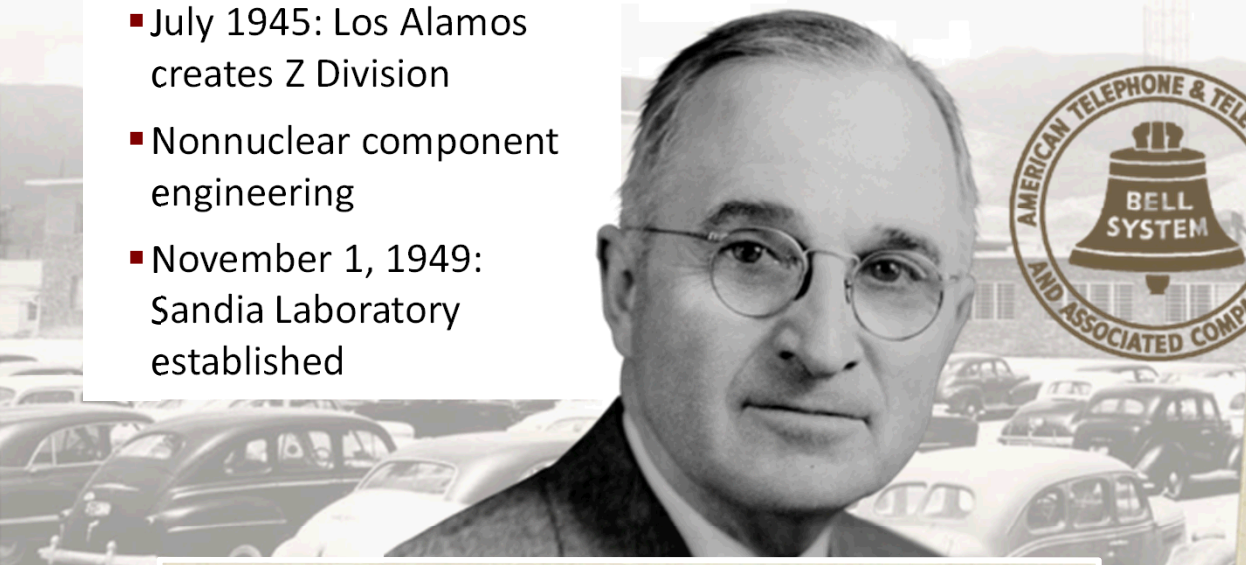
U.S. DEPARTMENT OF ENERGY | NNSA

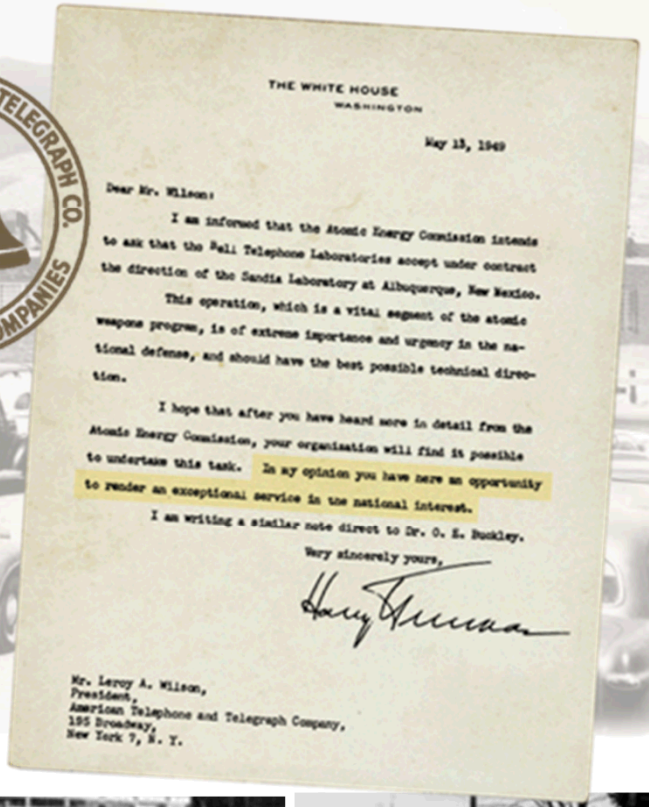
Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND No. 2012-10819P

# Sandia's History

*Exceptional service in the national interest*

- July 1945: Los Alamos creates Z Division
- Nonnuclear component engineering
- November 1, 1949: Sandia Laboratory established





THE WHITE HOUSE
WASHINGTON

May 13, 1949

Dear Mr. Wilson:

I am informed that the Atomic Energy Commission intends to ask that the Bell Telephone Laboratories accept under contract the direction of the Sandia Laboratory at Albuquerque, New Mexico.

This operation, which is a vital segment of the atomic weapons program, is of extreme importance and urgency in the national defense, and should have the best possible technical direction.

I hope that after you have heard more in detail from the Atomic Energy Commission, your organization will find it possible to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

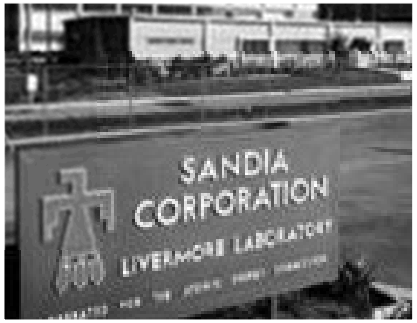
I am writing a similar note direct to Dr. O. E. Buckley.

Very sincerely yours,

Harry Truman

Mr. Leroy A. Wilson,
President,
American Telephone and Telegraph Company,
195 Broadway,
New York 7, N. Y.

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




# Sandia Addresses National Security Challenges

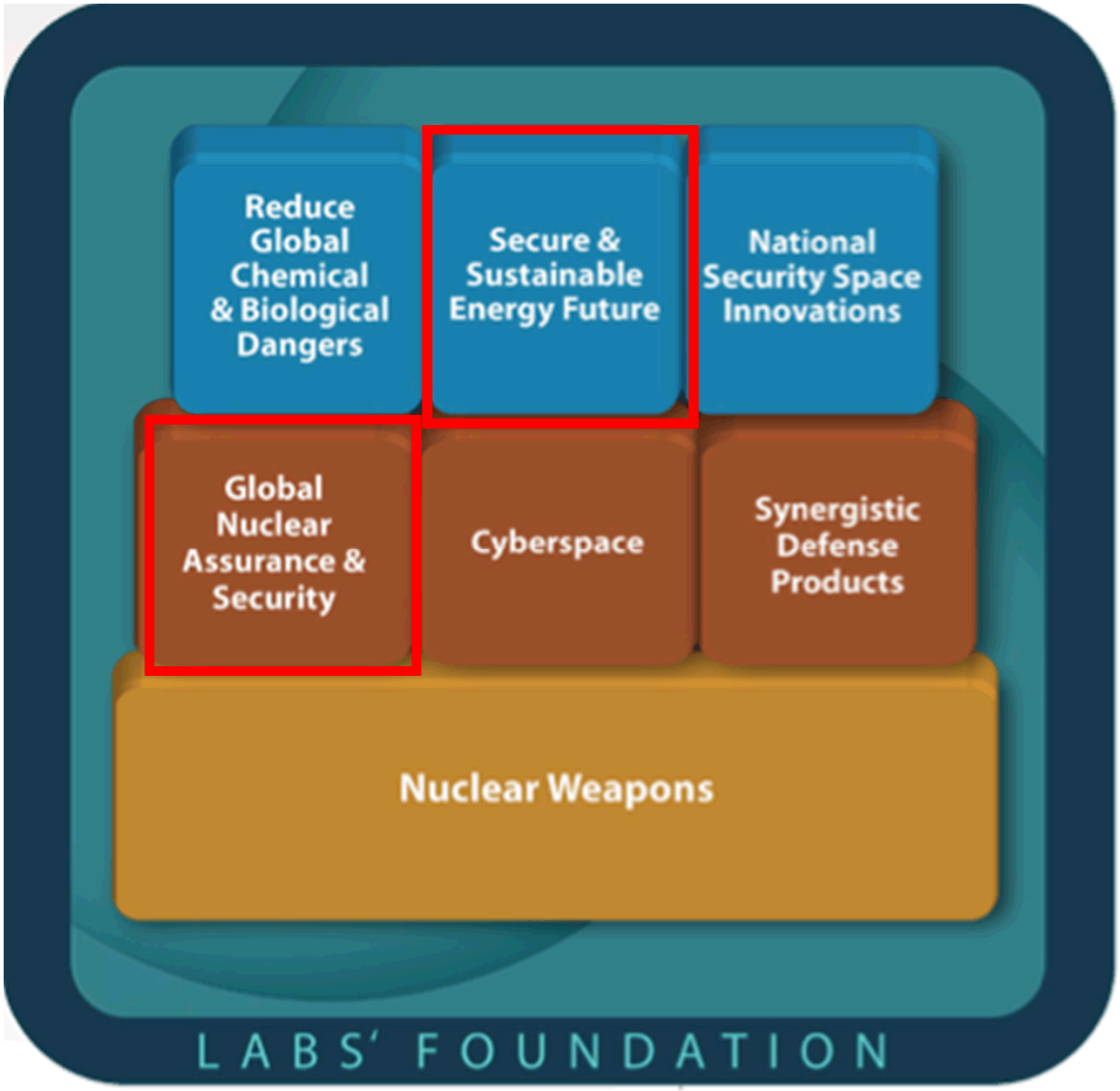
Sandia National Laboratories

| 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2010s |
|---|---|---|---|---|---|---|
| Nuclear weapons production and manufacturing engineering | Development engineering | Multiprogram laboratory | Missile defense work | Post–Cold War transition | Expanded national security role | LEPs<br>Cyber, Biosecurity<br>Proliferation |
| | Vietnam War | Energy crisis | | Stockpile stewardship | 9/11 | |
| | Partial Test Ban Treaty | Nuclear Nonproliferation Treaty | INF Verification INFCIRC/153 | START INFCIRC/540 | Proliferation Security Initiative | New START |






# Sandia's National Security Mission Areas



# Energy & Climate

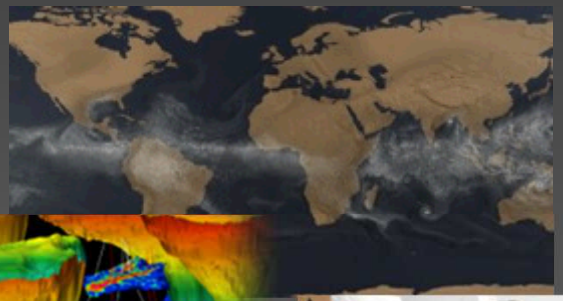
Sandia National Laboratories

## Energy Research

ARPAe, BES Chem Sciences, ASCR, CINT, Geo Bio Science, BES Material Science

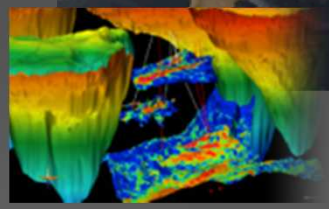
## Climate & Environment

Measurement & Modeling, Carbon Management, Water & Environment, and Biofuels



## Nuclear Energy & Fuel Cycle

Commercial Nuclear Power & Fuel, Nuclear Energy Safety & Security, DOE Managed Nuclear Waste Disposal

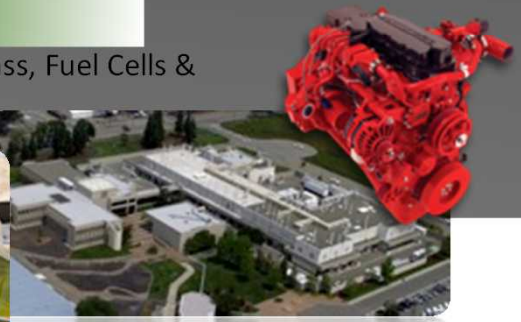


## Renewable Systems & Energy Infrastructure

Renewable Energy, Energy Efficiency, Grid and Storage Systems

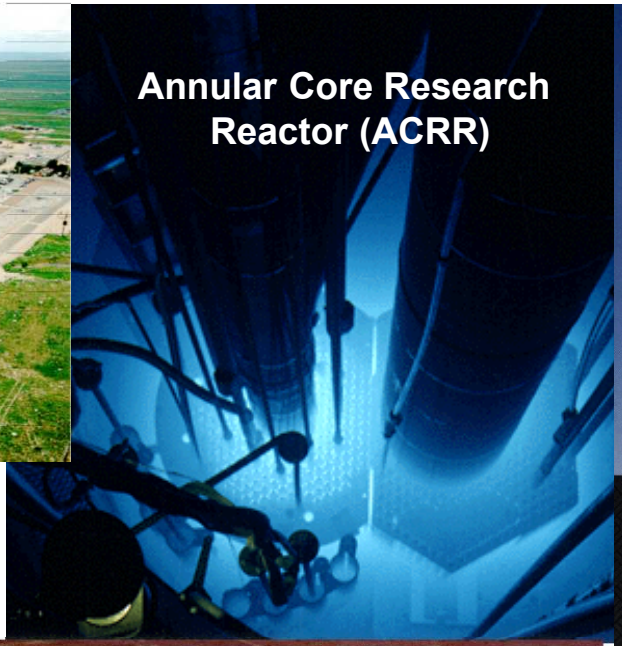
## Transportation Energy & Systems

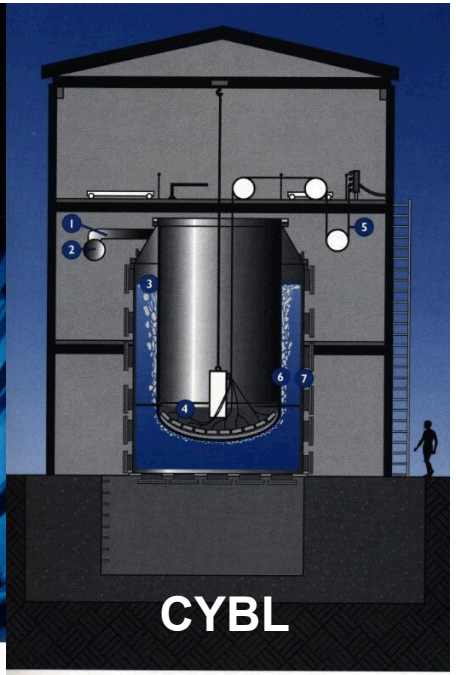
Vehicle Technologies, Biomass, Fuel Cells & Hydrogen Technology

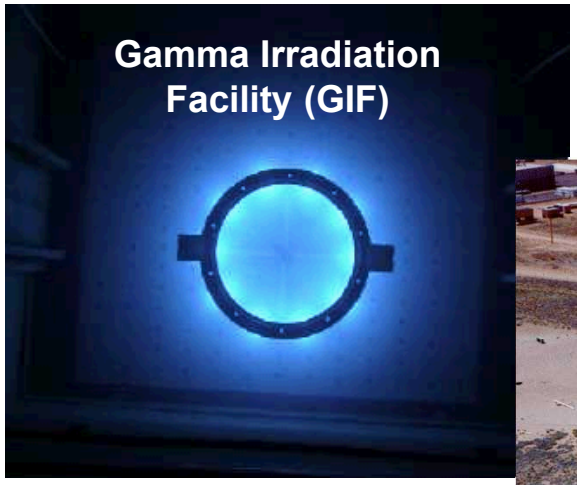


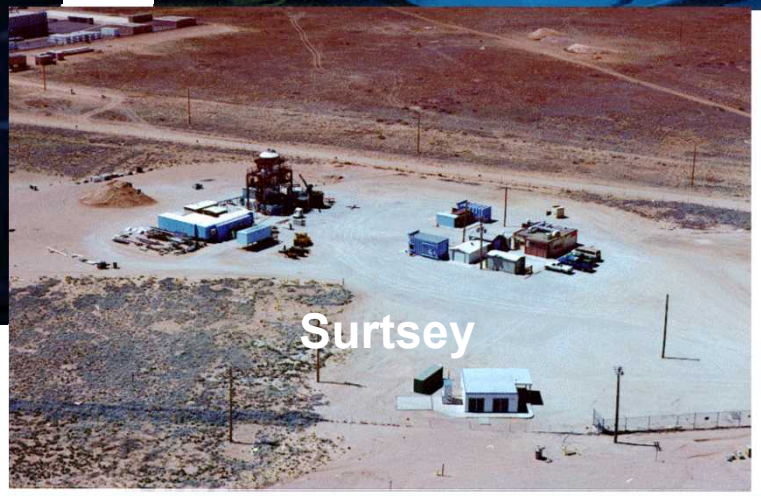
# Nuclear Energy Experimental Facilities

Sandia National Laboratories



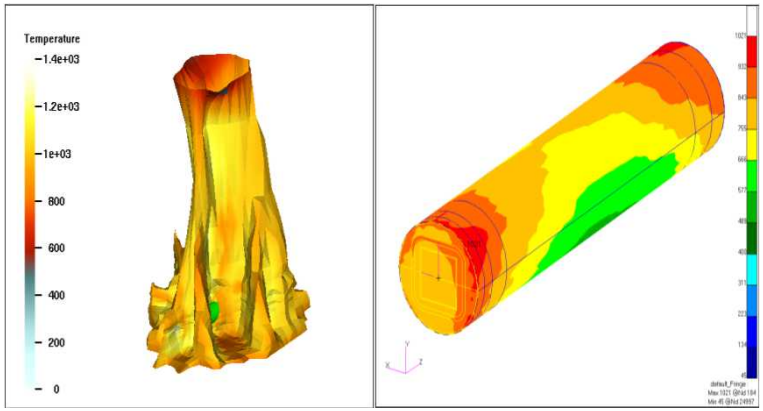



# Nuclear Security and Safety Testing Facilities

Sandia National Laboratories

Impact Testing




Fire Testing and Modeling

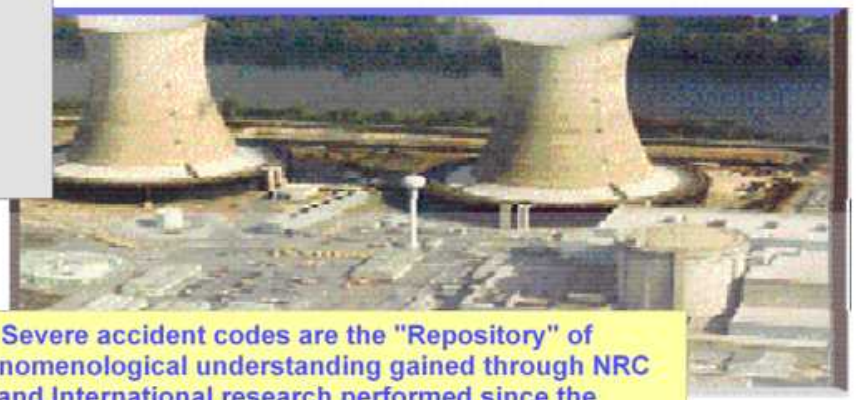
F4 Crash Test
(Japan)

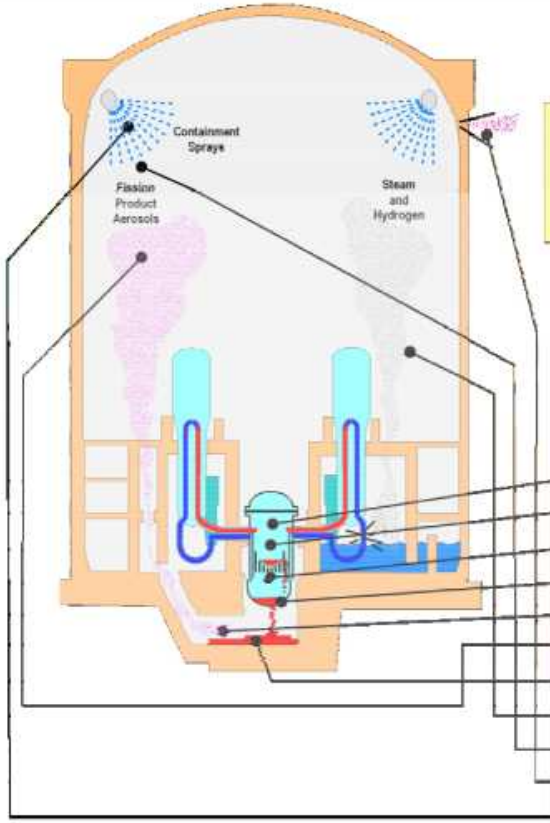
¼-Scale Prestressed Concrete
Containment Vessel Test to Failure
(Japan)

# Modeling Severe Reactor Accidents

Sandia National Laboratories

## Modeling and Analysis of Severe Accidents in Nuclear Power Plants






Severe accident codes are the "Repository" of phenomenological understanding gained through NRC and International research performed since the TMI-2 accident in 1979

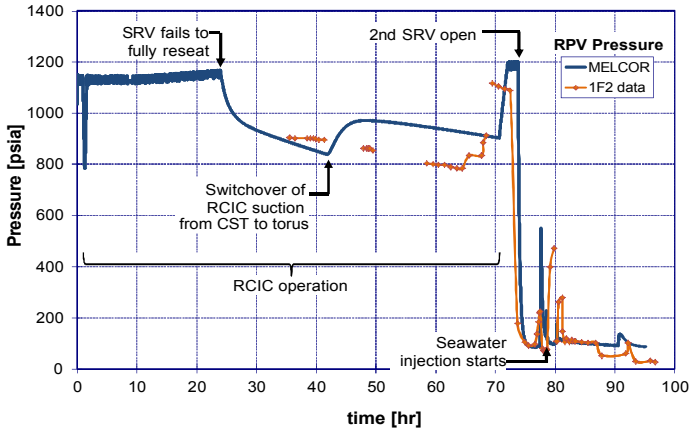
*Integrated models required for self consistent analysis*

**Important Severe Accident Phenomena**

| | MELCOR | CONTAIN | VICTORIA | SCDAP RELAP 5 |
|---|---|---|---|---|
| Accident initiation | ■ | | | ■ |
| Reactor coolant thermal hydraulics | ■ | | | ■ |
| Loss of core coolant | ■ | | | ■ |
| Core meltdown and fission product release | ■ | | ◢ | ■ |
| Reactor vessel failure | ■ | | | ■ |
| Transport of fission products in RCS and Containment | ■ | ■ | ■ | |
| Fission product aerosol dynamics | ■ | ■ | ■ | |
| Molten core/basemat interactions | ■ | ■ | | |
| Containment thermal hydraulics | ■ | ■ | | |
| Fission product removal processes | ■ | ■ | ■ | |
| Release of fission products to environment | ■ | ■ | ■ | |
| Engineered safety systems - sprays, fan coolers, etc | ■ | ■ | | |
| Iodine chemistry, and more | ■ | | | |

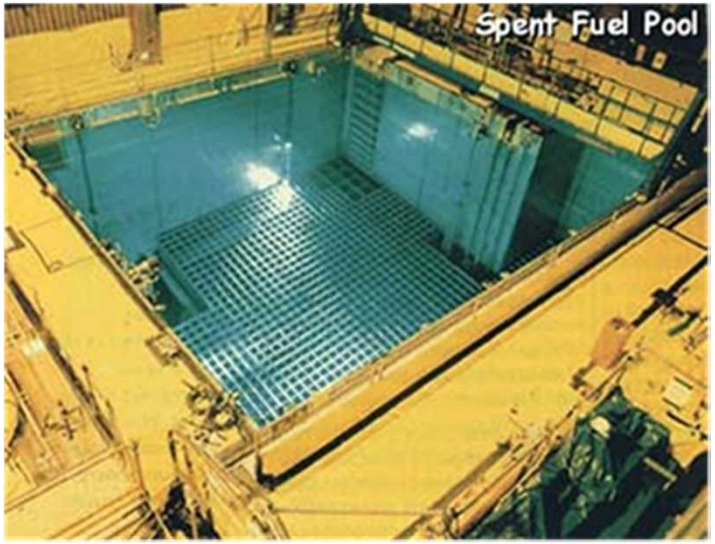
# Fukushima Daiichi Response & Forensics

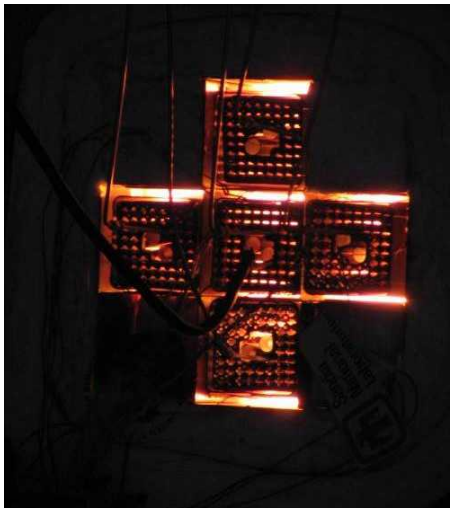
- In-country support
  - US Embassy
  - Consequence management
  - Seawater decontamination
- Accident reconstruction and definition of critical data for recovery
- Implications for US reactors and the regulatory process
- Critical nuclear safety equipment testing proposal



# Safety of Spent Fuel Pools

- **Experiments and modeling**



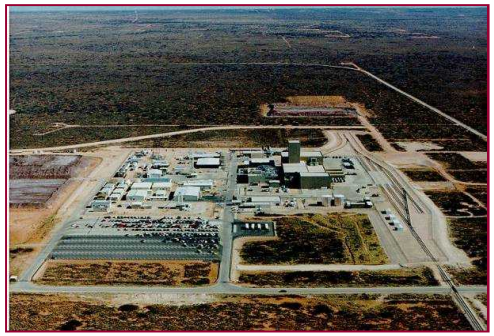



*Heat-up of fuel bundles following pool drain event*

*Fuel bundle assembly after the test*

# National Leadership in Nuclear Waste Management

Sandia National Laboratories



**Science Advisor for Waste Isolation Pilot Plant**

**Lead Laboratory for Yucca Mountain Project**

**National Technical Director for Used Fuel Disposition Program**

# International, Homeland, & Nuclear Security

Sandia National Laboratories

**Global Security**

**WMD Counterterrorism and Response**

**Homeland Security Programs**

**Homeland Defense and Force Protection**

**Cyber and Infrastructure Security**

# Global Nuclear Security – A Top Priority for President Obama and the International Community

*… we must ensure that terrorists never acquire a nuclear weapon. This is the most immediate and extreme threat to global security. One terrorist with one nuclear weapon could unleash massive destruction. … And we know that there is unsecured nuclear material across the globe.*

*So today I am announcing a new international effort to secure all vulnerable nuclear material around the world within four years.*

Prague, Czech Republic
April 5, 2009

Seoul, Republic of Korea
March 26, 2012

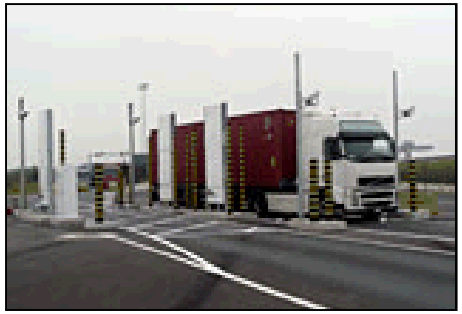
*We've agreed that nuclear terrorism is one of the most urgent and serious threats to global security …[and] to the goal of securing the world's nuclear materials in four years.*

*What is also undeniable is that the threat remains … [and that] the security of the world depends on the actions we take … to reduce the dangers of nuclear weapons and nuclear terrorism.*

# The Global Security Program mission is focused on a broad threat

Sandia National Laboratories

***Mission: Reducing proliferation and terrorism threats to U.S. national security through global technical engagement***



## Multi-Threat Risk Reduction

- Limit the spread of sensitive materials and technologies by:
  - Reducing motivation to acquire/use WMD
  - Impeding access by proliferators to WMD expertise
  - Securing borders and ports
  - Securing critical materials and facilities

## Nuclear and Radiological Risks

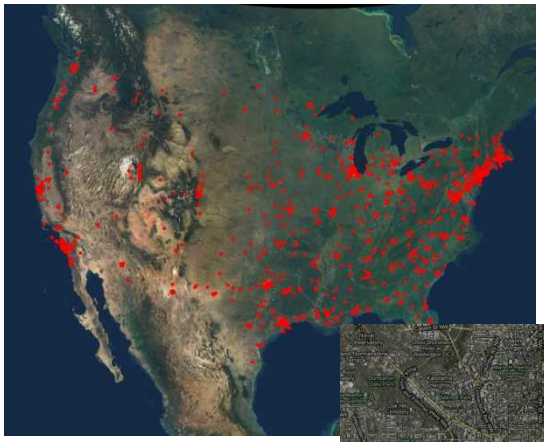
- Reduce the threat from malevolent use of nuclear and radiological materials.

## Biological and Chemical Risks

- Reduce the risk from the malevolent use of biological and chemical materials.

# Global Cooperative Threat Reduction
# Example: Global Threat Reduction Initiative

Sandia National Laboratories



Threat


Consequence

Prevention


BN-350 60th at Baikal

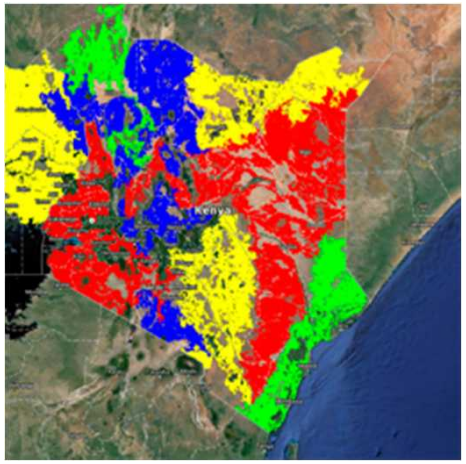
BN-350 Casks on pad (November 15, 2010)

# Facilities: Nonproliferation Program

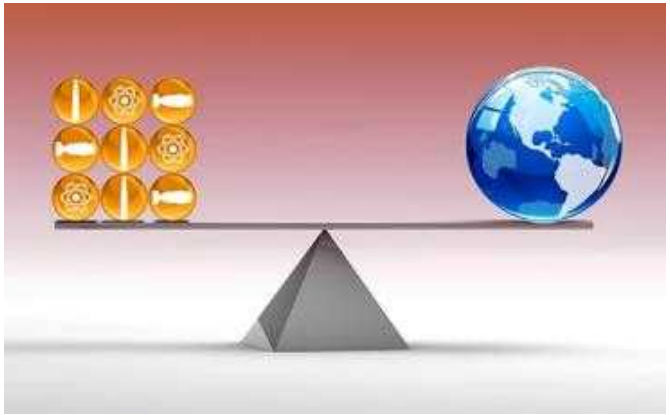
- Integrated Security Facility (ISF)
  - Previously a Cat 1 facility
  - Adding demonstrated systems view of 3S
  - Highest level nuclear security system
  - Train security professionals
  - Test next-generation security systems

# Systems Analysis

- Country vulnerability prioritization modeling



- Nuclear zero and global stability



# Center for Global Security and Cooperation

Sandia National Laboratories


- Seeking a safe, secure world through global technical engagement
  - System Solutions
  - Research and Development
  - Systems Analysis
  - Solutions Engineering
  - Policy engagement
  - **Enduring Partnerships**
- Strengthening nonproliferation and reducing global threats
  - Research, develop, and apply innovative science and engineering solutions
  - Engagements
  - Capacity building

# Enduring Partnerships

- Cooperative Monitoring Center
  - Founded at SNL NM to support global political/technical engagements
  - Visiting Scholars Program
    - Over 50 scholars from 20 countries

- International Atomic Energy Agency
  - Nuclear Security
  - Physical protection
    - Assessments, capacity building and SMEs
  - International Safeguards
    - Containment/Surveillance technologies and SMEs

# Additional Models of Partnership

MESIS

معهد الشرق الأوسط العلمي للأمن

Middle East Scientific Institute for Security

- Established at the Royal Scientific Society (RSS) of Jordan in Amman
- Originally a Sandia-RSS partnership; now autonomous
- The mission is to promote a culture of peace in the Middle East through application of cooperative security concepts and confidence-building measures.

GNEII at KHALIFA UNIVERSITY

**Gulf Nuclear Energy Infrastructure Institute (GNEII)**

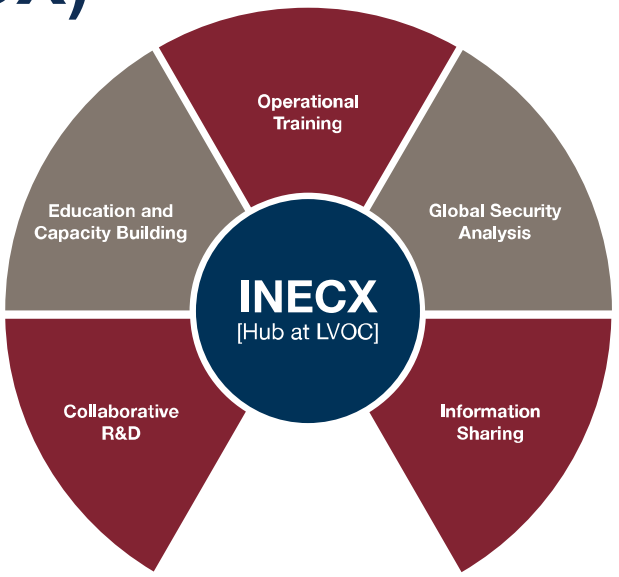
*Mission:* GNEII seeks to develop a responsible nuclear energy culture and institutionalize key safety, safeguards, security, and nonproliferation norms in the future decision-makers of Middle East region nuclear energy programs through professional development and training.

# Institute for Nuclear Energy Collaboration and Exchange (INECX)

Proposed institute, at Sandia/CA, would bring together foreign nuclear power operators, researchers, regulators, and officials to collaboratively train and work on projects that enhance 3SC, fulfilling our nation's responsibilities under the NPT.

**Mission**:

To support responsible and peaceful growth of civilian nuclear energy globally by advancing 3S of the nuclear energy lifecycle through technical exchange and collaborative R&D




## Southeast Asia Nuclear Energy Infrastructure Institute (SEANEII)

- Proposal to provide education, research and technological demonstration strategy to enhance the abilities of regional nuclear energy professions in nuclear 3SC and nonproliferation.
- Propose to develop curriculum, establish facilities, manage logistics, provide instructors, serve as research mentors, and develop a sustainability plan

# GENI (Global Emerging market Nuclear non-proliferation Initiative)

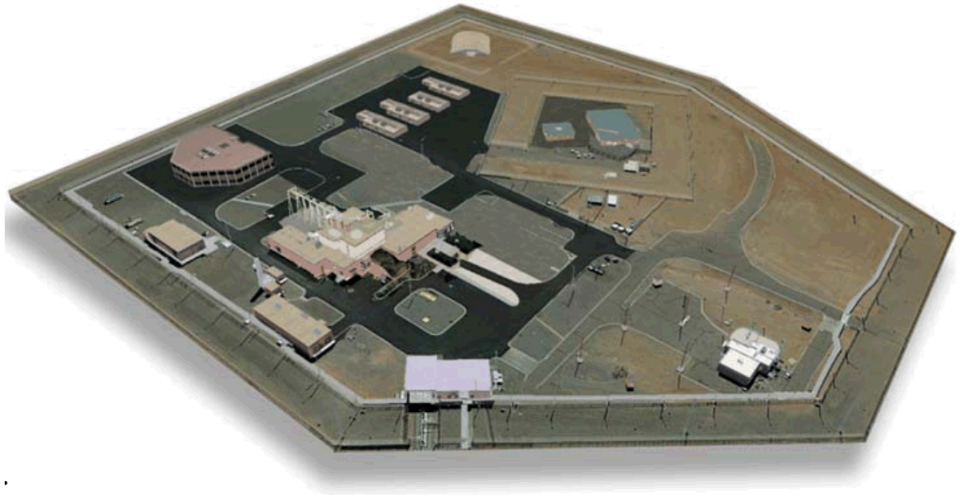
Sandia National Laboratories

The primary aim is to develop a partnership between the Korea Institute for Nuclear Nonproliferation and Control (KINAC) and Sandia's Center for Global Security and Cooperation (CGSC) that will address the growing need for strengthened research, education and training in key aspects of the civilian nuclear enterprise.

**Collaboration Objective:**
Engage Gulf Cooperation Council (GCC) member states, along with countries in Africa and Southeast Asia, to serve as foundational partners in the peaceful use of nuclear energy in their regions.

# GENI - Potential Projects

**Nuclear Security and Physical Protection:**
Leverage existing capabilities to enhance physical protection elements in the Middle East and other emerging markets to protect nuclear infrastructure against various physical and cyber threats.



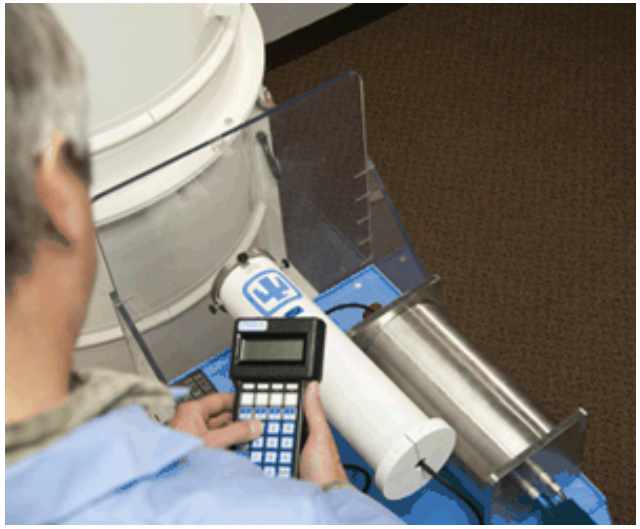
**Address Spent Nuclear Fuel:**
Work with member states to understand potential Spent Nuclear Fuel issues, implications and solutions. This could entail leveraging Sandia's SNF modeling capabilities or identifying regional schemes for SNF storage and disposal.

# GENI - Potential Projects

Sandia National Laboratories

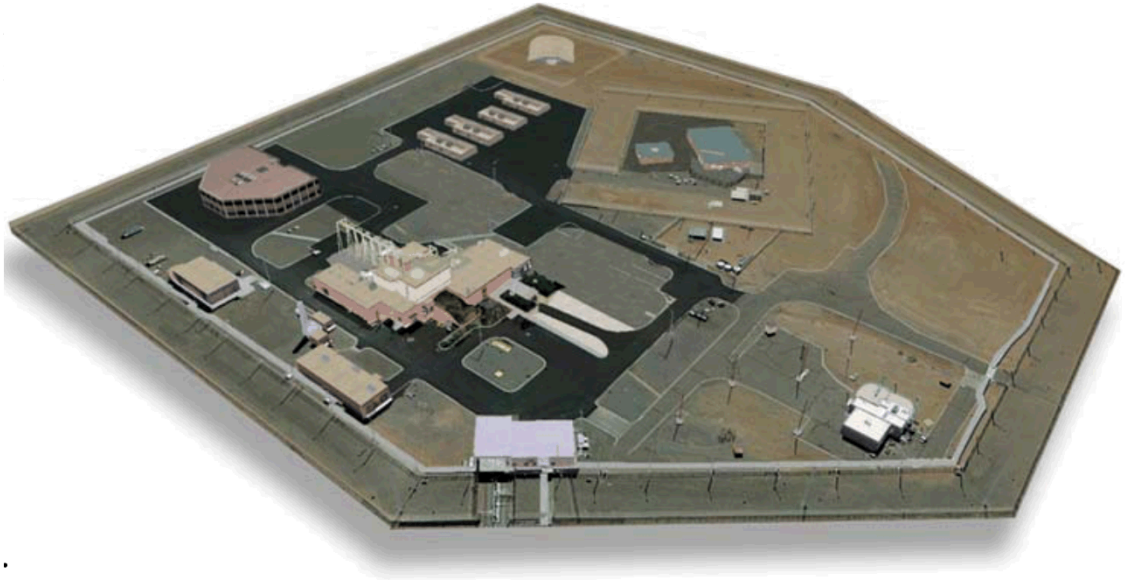
**Understand Enrichment and Reprocessing (E&R):**
Address the value of understanding the full political, economic and social costs of E&R through Table Top Exercises (TTX) with experts

**Encourage Transparency:**
Encourage member interaction and open discussion on the nuclear decision making process. Share experiences of RoK as a core example of a NNWS openly interacting with international nuclear community.



# Example: Nuclear Security and Physical Protection

Sandia National Laboratories



**The Integrated Security Facility (ISF):** A research, development, testing and training area using a fully functional and integrated physical protection system. It is the only environment in the world that has the highest rigor nuclear security systems available for developing next generation security systems and training security engineers and technologists.

- **Perimeter Intrusion Detection**
- **Entry Control Point**
- **Central Alarm Station**
- **Processing Facility**
- **Material Receiving**

**Potential GENI Opportunities:**

- Introduce key PP Elements with partners.
  - Lectures, field experience, timeline analysis, force-on-force issues.
- Cyber security for nuclear facilities as proposed by USNRC 8 Milestone Pathway.
  - Cyber-security by design, integrated into safety analysis
  - Seminars to understand fundamentals of securing future facilities

# GENI Discussion – Program Structure Options

Sandia National Laboratories

Current GENI Primary Objective: To develop a partnership that will address the growing need for strengthened research, education and training in key aspects of the civilian nuclear enterprise.

**Potential Models Of Cooperation:**

- **Academic Model - Collaborative research & development agenda with shared technical challenges of common concern.**
- **Training Model - Promoting best practices through training, exercises and workshops**
- **Conference Model - Convene member experts through conferences and technical symposia.**

How can the GENI model integrate with other international and regional institutions such as GNEII, MESIS and IAEA?

# GENI Discussion – Potential US Partners

**NNSA:**

**NA21 - Global Nuclear Security (Physical Protection), Nuclear Culture**

**NA24 - Nonproliferation & International Security**

**US Nuclear Regulatory Commission:**

**May be interested especially with participation of RoK regulators.**

**US Department of State:**

**International collaboration on nuclear Security culture..**

# GENI Discussion – Path Forward

Sandia National Laboratories

**What?**

What is the vision? What specific projects can help us achieve that vision?

**How?**

What is the model of GENI? Who will partner with us? How do these pieces fit together?

**When?**

What is the timeline and next steps to achieve the GENI vision.