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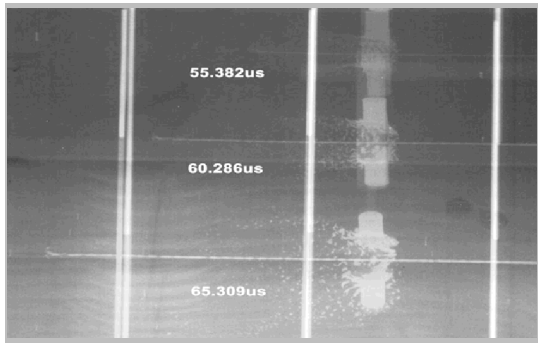

Used Fuel Security – Prioritized Issues and R&D Needs

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U.S. DEPARTMENT OF ENERGY | NNSA Nuclear National Security Administration

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Presentation Outline

- **Used Fuel Storage Security Objectives and Key Drivers**
- **Recommendations from Previous Studies**
- **Prioritized Issues/Research and Development Needs**
- **Ongoing and Planned Activities**
  - **NRC Exchange**
  - **Planning for Proposed Restart of Cask Sabotage Program**
  - **Security Risk Assessment Methodology**
- **Challenges for Maintaining Security for Extended Storage**

Used Fuel Storage Security – Objectives and Key Drivers

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- **Work being performed as part of the U.S. Department of Energy Office of Nuclear Energy (DOE/NE) Fuel Cycle Technologies (FCT) Program**
  - **Material Protection, Accounting and Control Technologies (MPACT) Campaign**
- **Objectives**
  - **Identify and evaluate security issues related to extended storage of used nuclear fuel**
  - **Perform technical analyses and develop guidance documents**
    - **Assure security risks for extended storage are understood and minimized**
    - **Address stakeholder concerns with reliable and technically sound information**
  - **Support overall objectives for Used Fuel Storage and Transportation R&D**
- **Key Drivers for Prioritized Issues and R&D Needs**
  - **FY2012 Used Fuel Disposition (UFD)/MPACT Transition**
  - **Initial development of MPACT used fuel safeguards and security activities**
  - **Revisit security issues in light of Blue Ribbon Commission (BRC) recommendations and other previous studies**
  - **Extend and complement pre-BRC UFD work**

Some Recommendations from Previous Studies

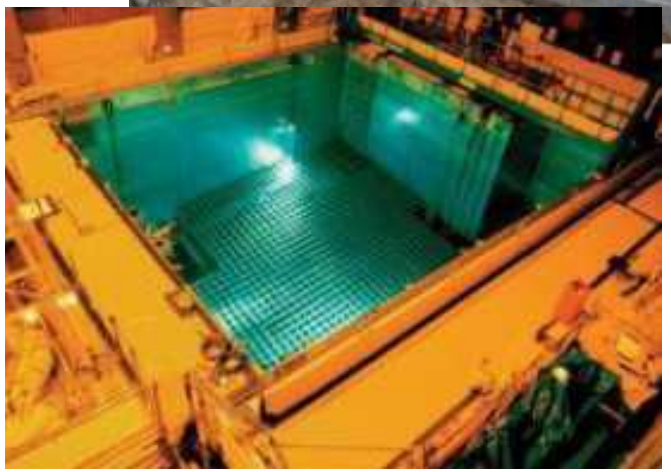
- **BRC Recommendations Relevant for Used Fuel Storage**
  - **Prompt efforts to develop one or more consolidated storage facilities as part of an integrated plan for managing the back end of the fuel cycle**
  - **Prompt efforts to prepare for the eventual large-scale transport of spent nuclear fuel and high-level waste to consolidated storage**
  - **Support for continued U.S. innovation in nuclear energy technology and for workforce development**
  - **Active U.S. leadership in international efforts to address safety, waste management, non-proliferation, and security concerns**
- **BRC Recommendations Related to Used Fuel Storage Security**
  - **Assessment of lessons learned from Fukushima**
  - **Revisiting spent fuel security studies**
  - **Continued R&D on vulnerability and terrorism**
  - **Examination of "hardened" storage concept**

Some Recommendations from Previous Studies (concluded)

- **Another Important BRC Comment**
  - **The BRC calls for the U.S. to work with the international community "to ensure that all spent fuel remains under effective and transparent control and does not become 'orphaned' anywhere in the world with inadequate safeguards and security" [p. xiv, BRC report, 2012].**
- **Recommendations from Other Studies**
  - **Additional analyses to understand and address threats, vulnerabilities and consequences (NAS)**
  - **Consolidated storage for stranded fuel only to reduce operational costs while avoiding additional risks of transportation (MIT)**
  - **Reduce security risks by improving transportation operations (GAO)**

Summary of Prioritized Issues – MPACT R&D Planning

- **Highest Priority Issues**
  - **Vulnerabilities and Risks of Sabotage and Terrorist Attacks**
  - **Best Practices for Consolidated Storage**
  - **Surveillance and Security Measures for Individual Fuel Rods and Portions of Rods**
- **Moderate Priority Issue**
  - **Improved Safeguards for Monitoring, Accounting and Control of Used Fuel**
- **Lower Priority Issue**
  - **Issues for Pool Storage of Used Fuel**



Summary of Ongoing and Planned Work

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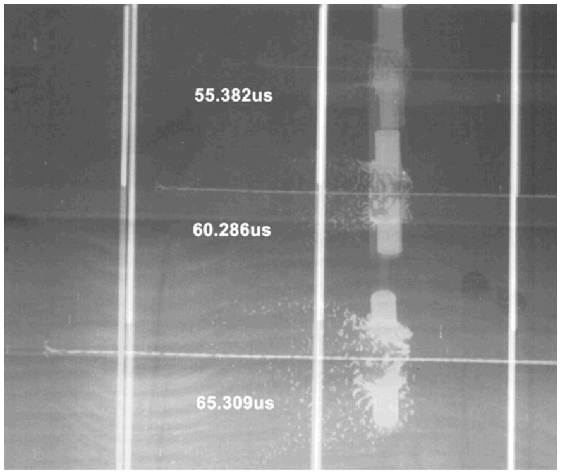
- **NRC Exchange**
- **Planning for Proposed Restart of Cask Sabotage Program**
- **Security Risk Assessment Methodology**

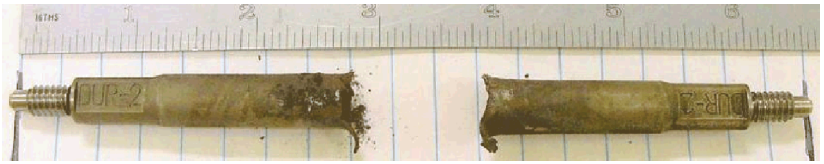
NRC Technical Exchange

- **Information Exchange**
  - **Present technical work that the U.S. DOE Used Fuel Disposition Campaign has performed over the last two years**
  - **Share methods and analyses**
  - **Elicit comments – NRC staff perspective**
- **Discuss Possible Collaborative Efforts**
  - **Share information from past studies**
  - **Identify possible collaboration activities**
- **Key Meeting Outcomes**
  - **Methods were very well received**
  - **Memorandum of Understanding/Process to share security studies**
  - **Interest in restarting international spent fuel sabotage test program to develop aerosolization and respirable fraction data**

Restart of Cask Sabotage Program

- **Why?**
  - **Release from explosively disrupted spent fuel rods has not been adequately measured**
    - **Previous studies have wide range of uncertainty**
    - **Needed for consequence analysis**
- **What?**
  - **Measure release**
  - **Determine Spent Fuel Ratio (SFR)**
    - **Allows scaling from full-scale surrogate tests**
- **How?**
  - **Review previous work**
  - **Develop scoping plan and cost estimate**
  - **Re-establish teaming relationships**





Security Assessment Methodology

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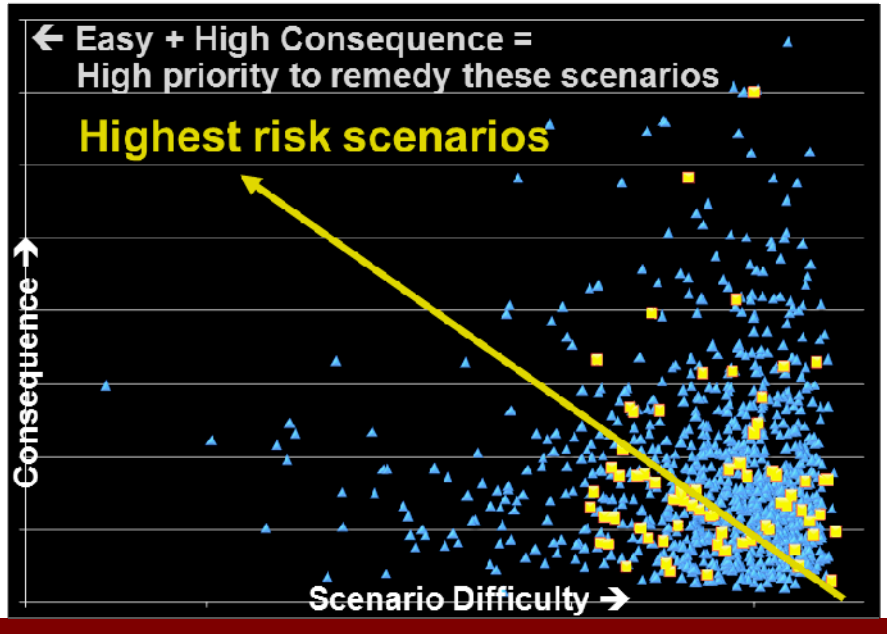
- **Based on Risk-Informed Management of Enterprise Security (RIMES) method for prioritizing security investment options**
- **Rather than using a traditional method that relies on highly uncertain probability of attack, the method uses approaches to describe the difficulty for an adversary to successfully prepare and execute an attack that can produce a given level of consequences**
  - **Approach focuses on Difficulty of Attack and Consequences associated with an attack scenario**
  - **Allows comparison and prioritization across multiple targets/ facilities across an enterprise**

Security Assessment Methodology

- **Application for Used Fuel Storage Security**
  - **Evaluation of sabotage and theft scenarios**
  - **Preliminary evaluation of factors that change over the timeframe of extended storage**
  - **Basis for developing recommended protection strategies for extended storage**



Challenges for Addressing Safeguards and Security Issues for *Extended* Storage

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- **How do we address identified security issues?**
  - **Different requirements – categorization of materials, roll up, threat and level of protection measures**
  - **Definition and evolution of the adversary attack characteristics**
  - **Applicability of the concept of self-protection for used fuel**
  - **Risk of stranded fuel at decommissioned reactors**
- **Do security protection requirements and strategies change for the extended timeframe and different concepts?**
  - **Evaluate storage configurations identified in the FCT Systems Architecture Study**
  - **Facility protection measures integrated with aspects of cask/fuel design that contribute to security over the system life cycle**
- **Security Risk Assessment approach provides framework for addressing many of these issues**
  - **Level of protection commensurate with security risk over the period of extended storage**
- **R&D activities to address other identified issues**

BACKUP SLIDES

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R&D Needs – for MPACT Used Fuel Storage Security Program Planning

- **Identify R&D Needs for Program Planning**
  - **Prioritized Issues**
  - **Past and ongoing UFD/MPACT used fuel storage security assessment**
  - **Technical Exchange with NRC**
  - **Coordinate and Complement Other FCT Efforts**
- **Develop R&D Activities to Address Each Issue**
  - **Security Risk Assessment and Consequence Analyses**
    - **Different storage concepts, accelerated transfer operations, consideration of additional vulnerabilities**
    - **Zirconium fires in storage casks – computational modeling**
    - **Proposed restart of international cask sabotage test program**
  - **Best Practices – Planning Workshop with World Institute of Nuclear Security**
  - **Improved monitoring, accounting and control technologies**

To *Manage* Security Risk, One Must Consider Adversary Decision Criteria

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Adversary's Decision Criterion	How we make an attack less likely
"Could I do it if I wanted to?"	
"Would I do it if I could?"	
"Are the expected consequences high enough?"	

Attack scenarios:
Easy
&
High-Consequence
=
High Risk

Difficulty of Scenarios: An Adversary's Perspective

Attack Preparation

- Outsider attack participants
  - *Number, training & expertise required*
- Insider attack participants
  - *Number, coordination & level of access*
- Organizational support structure
  - *Size, capabilities, intelligence & OPSEC*
- Availability of required tools
  - *Rarity, signatures for law enforcement*

Attack Execution

- Ingenuity & inventiveness
- Situational understanding
  - *Observability & transience of vuln.*
- Stealth & covertness
- Dedication & commitment
  - *Risk to outsider & insider participants*
- Operational complexity/flexibility
  - *Precision coordination of disparate tasks*

Difficulty for Baseline Scenarios

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		1	2	3
Attack Planning & Preparation	Participants	2 (3)	2 (3)	3 (9)
	Training	2-3 (3-9)	2-3 (3-9)	4+ (27+)
	Support	1 (1)	1 (1)	3 (9)
	Tools	3 (9)	3 (9)	2 (3)
	# of Insiders	1 (1)	1 (1)	2+ (3+)
	Insider Access	1 (1)	1 (1)	2+ (3+)
	Ingenuity	2 (3)	2-3 (3-9)	3 (9)
Attack Execution	Situational Understanding	1 (1)	1 (1)	2 (3)
	Stealth & Covertness	1 (1)	1 (1)	3-4 (9-27)
	Outsider Commitment	2 (3)	3 (9)	4 (27)
	Insider Commitment	1 (1)	1 (1)	1 (1)
	Complexity	1 (1)	1 (1)	4 (27)
	Flexibility	1 (1)	1 (1)	4 (27)
Aggregated Score		-- *(26-32)*	-- *(34-46)*	-- *(121-193)*

Level ***(Score)*** *[1, 2, 3, 4, 5 → 1, 3, 9, 27, 81]*

Legend:

Radiological Sabotage

1. **Cask Breach**
2. **Enhanced Dispersal**
3. **Theft of Used Nuclear Fuel**

Score for each level is 3x that of the next lower level in this example.