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Used Fuel Security – Prioritized Issues, R&D Needs, Best Practices and Security Risk Analysis for Extended Storage

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Presentation Outline

- Used Fuel Storage Security Objectives and Activities
- Prioritized Issues
- Research and Development Needs
- Summary of Security Risk Assessment Efforts
- Technical Exchange with U.S. Nuclear Regulatory Commission

Used Fuel Storage Security Objectives and Activities

- **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
- **FY2012/FY2013 MPACT Used Fuel Storage Security Activities**
  - Develop activities in light of Blue Ribbon Commission recommendations
  - Prioritized List of Issues for planning program efforts (Sep FY12)
  - Research & Development Needs Program Plan (Mar FY13)
  - Continue security risk assessments for extended storage (Jun FY13)
  - World Institute of Nuclear Security Best Practices Workshop (FY12/FY13)

Prioritized Safeguards and Security Issues for Extended Storage of Used Fuel

- **Key Drivers**
  - 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
  - Extend and complement pre-BRC UFD work
- **Approach**
  - Revisit past studies - Thirteen studies that have addressed used (spent) fuel safeguards and security
    - BRC Report (2012)
    - Government Accountability Office (GAO) studies (2003, 2009, 2011, 2012)
    - National Academies of Science (NAS) studies (2001, 2003, 2006)
    - Others (MIT – 2010, 2011; ANS – 2011; IAEA, 2003; FAS – 2010)
  - Review key recommendations and UFD R&D work
  - Identify issues and prioritize on a relative basis
  - Peer review of report

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 threats, vulnerabilities, and consequences for pool and dry storage and movement to dry storage; take appropriate actions to address vulnerabilities and reduce consequences; review and upgrade of security requirements for individual rods and portions of rods; independent assessment of surveillance and security measures (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

- **Highest Priority Issues**
  - Vulnerabilities to 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

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
- **Responding to Review Comments on March Draft Report**

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

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

		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.

Technical Exchange with NRC

- **Information Exchange**
  - Present technical work that the UFD and MPACT Campaigns have performed since FY2010
  - Share methods and analyses
  - Elicit comments – NRC staff perspective
- **Discuss Possible Collaborative Efforts**
  - Share information from past security studies
- **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

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

- **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**