Limiting Future Proliferation and Security Risks

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Office of Science
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Comparison/Distinctions

Proliferation Resistance

- Host state is adversary
- Threats are
  - Diversion
  - Misuse
  - Breakout
- International Safeguards
- Slow moving events
  (not always)
- International implications

Physical Protection

- Sub-national is adversary
- Threats are
  - Material Theft
  - Information Theft
  - Sabotage
- Security/Safeguards
- Fast moving events
  (sometimes)
- Regional implications

Science-Based Approach to Proliferation Resistance and Physical Protection (PR&PP)

Threats

PR
- Diversion
- Misuse
- Breakout
- Clandestine Facility

PP
- Theft
- Sabotage

PR & PP

Intrinsic
Physical & technical design features

Extrinsic
Institutional arrangements

Assessment

Measures
- Material Type
- Detection Probability
- Technical Difficulty
- Proliferation Time
- Proliferation Cost
- Safeguards Cost

- Adversary Success Probability & Consequence
- Security Cost

Methodology Report approved for unlimited public distribution by the Generation IV International Forum: http://www.gen-4.org/Technology/horizontal/PRPPEM.pdf

Threat Considerations

	Proliferation Resistance	Physical Protection
Actor Type	• Host State	• Outsider • Outsider with insider • Insider alone • Above and non-Host State
Actor Capabilities	• Technical skills • Resources (money and workforce) • Uranium and Thorium resources • Industrial capabilities • Nuclear capabilities	• Knowledge • Skills • Weapons and tools • Number of actors • Dedication
Objectives (relevant to the nuclear fuel cycle)	Nuclear weapon(s): • Number • Reliability • Ability to stockpile • Deliverability • Production rate	• Disruption of operations • Radiological release • Nuclear explosives • Radiation Dispersal Device • Information theft
Strategies	• Concealed diversion • Overt diversion • Concealed facility misuse • Overt facility misuse • Independent clandestine facility use	• Various modes of attack • Various tactics

Evaluations should consider…

- Policy directions (to formulate questions)
- Adversary context for threat definition
  - *Objectives*
  - *Capabilities*
  - *Strategies*
- System design features relevant to PR&PP
- Fuel cycle architecture
- Safeguards and security contexts
- Reference (baseline) for comparison
- 3 Stages for Evaluation: Acquisition, Processing, *Weaponization (not usually evaluated)*
- Proliferation, theft and sabotage involve **competing adversary and defender forces**. Important to recognize both perspectives and the human interplay.

Studies Performed*

- ESFR: Example Sodium Fast Reactor w/fuel cycle
- PRR-1: UREX1a, COEX, PUREX
- PRR-2: UREX suite, COEX, Pyro, PUREX
- PRR-3: SFR, VHTR, CANDU, ALWR
- SMR: Integral PWR, Barge Reactor

*ESFR performed by international group; others by U.S. participants for NNSA

Observations from Evaluation Process

- Multiple pathways/scenarios highlight fact there are no simple answers to the relative PR&PP advantages of different processes
- Even a qualitative analysis is useful for informing decision-makers on “big picture”— e.g., for which threat scenarios do particular process characteristics make a difference, and how, and where do they not.
- Useful framework for integrating key findings and insights from multiple, more narrowly focused, technical studies

The Policy-Technology Nexus

- Policy informs the statement of the questions to be addressed
- Technical evaluations are performed to provide clear statements of alternatives (indicating and displaying degrees of differentiation)
- Policy is then used again to help choose among the alternatives defined in the results

Do not infuse technical evaluation portion with subjective notions from policy

Questions and Issues That Future Studies Can Inform

- Relative advantages of alternative nuclear energy systems for various applications: energy generation, material production, waste treatment
- System architecture (e.g. once-through vs. closed fuel cycles)
- International arrangements (e.g. fuel leasing)
- Performance-Environment-Economics-Nonproliferation-Security-Safety Trade-offs

➢ Many stakeholders…information needs to be presented to ***each user*** in an understandable way