ADVANCED REACTOR SAFEGUARDS

Leveraging interfaces between domestic and international safeguards

PRESENTED BY

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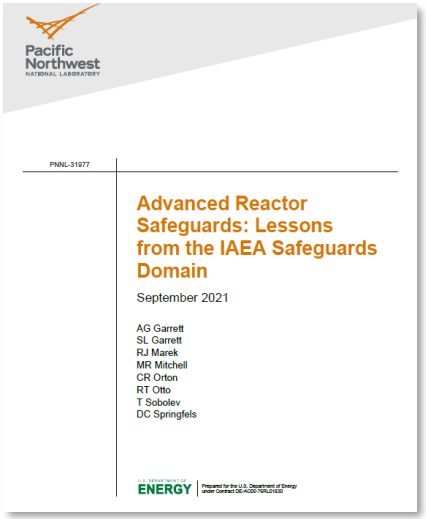
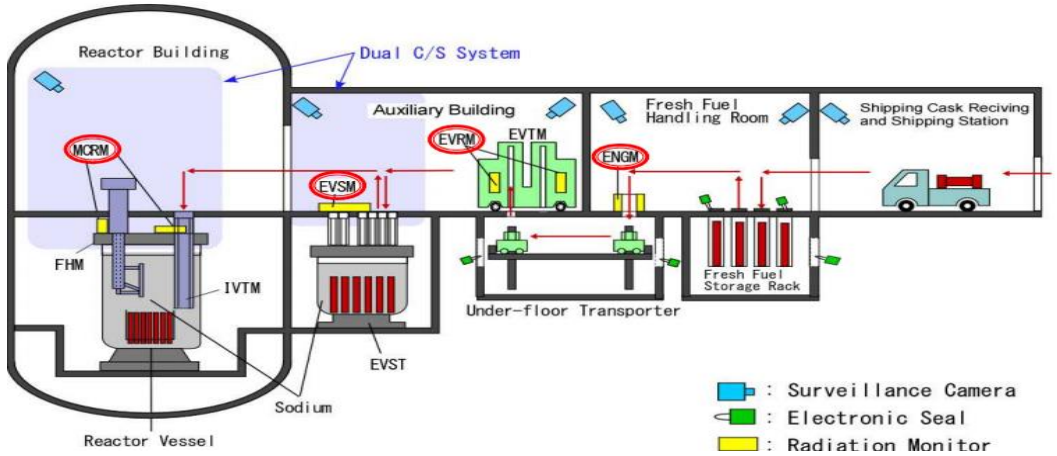
FY21 Topics

1. Where are the intersections and distinctions between U.S. domestic and IAEA safeguards?
2. What advanced reactors have been under IAEA safeguards and what can we learn from the IAEA safeguards approaches? What R&D from the IAEA safeguards domain might be relevant?
3. How can U.S. reactor developers prepare for potential IAEA safeguards requirements?





Identifying shared priorities

International Only

- Purpose: Verifying State declarations
- Independence from operator systems
- Systematic meas./accounting at assembly-fueled reactors

Intersection

- MC&A
- Tools for measuring bulk materials
- Tools for continuity of knowledge
- Dual-use operator measurement systems

Domestic only

- Purpose: Verifying licensee systems
- Physical protection, including from sabotage
- Institutional controls

FY22 Goals

- Facilitate stakeholder awareness of shared needs, interests, and R&D across DOE programs
- Serve as a resource to ARS research teams on IAEA safeguards applications

Review of ARS deliverables

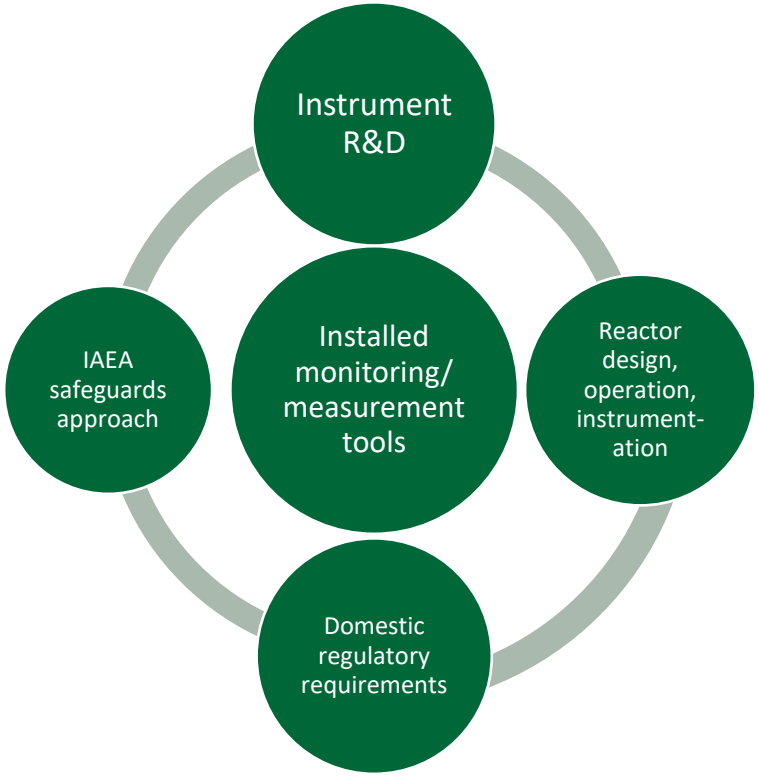
- Reviewed 10 studies
- Key areas of overlap: MC&A approaches, measurement systems for molten salt, pebble fuel, and other material types
- General observations for IAEA safeguards purposes
  - IAEA safeguards community should maintain awareness of MC&A regulatory developments, model FNMC plans, and measurement technologies under consideration.
  - How will IAEA measurement standards, information assurance, data needs affect operator MC&A decisions?
  - Helpful to ensure continued coordination as reactor systems designs proceed.
  - What impact could novel physical protection decisions have for safeguards (e.g. for microreactors)?

Review of ARISE deliverables

- Reviewed 16 studies
- Key topics included:
  - SMRs, microreactors and long-lived cores
  - Thorium fuel cycle issues (Pa-233, U-232)
  - MSR process monitoring
  - Stakeholder engagement
  - Fuel cycle processes and facilities
- Specific areas of relevance included:
  - Potential additional needs of IAEA – need for independent measurement regardless of physical protection
  - Integrating operator, State, and IAEA systems

Conclusions and recommendations

- U.S. MC&A and IAEA Safeguards planning should co-evolve
  - Engagement with NNSA, IAEA, NRC, and industry
- Continued information sharing with NNSA and IAEA
  - Elaborate IAEA safeguards needs/requirements for instrument R&D?
  - Facilitate IAEA technical awareness?
- Building on existing cooperation
  - Industry engagement: Natrium, eVinci, X-Energy
  - ARISE core team – ARS meetings?
  - Updates, proposal review process?



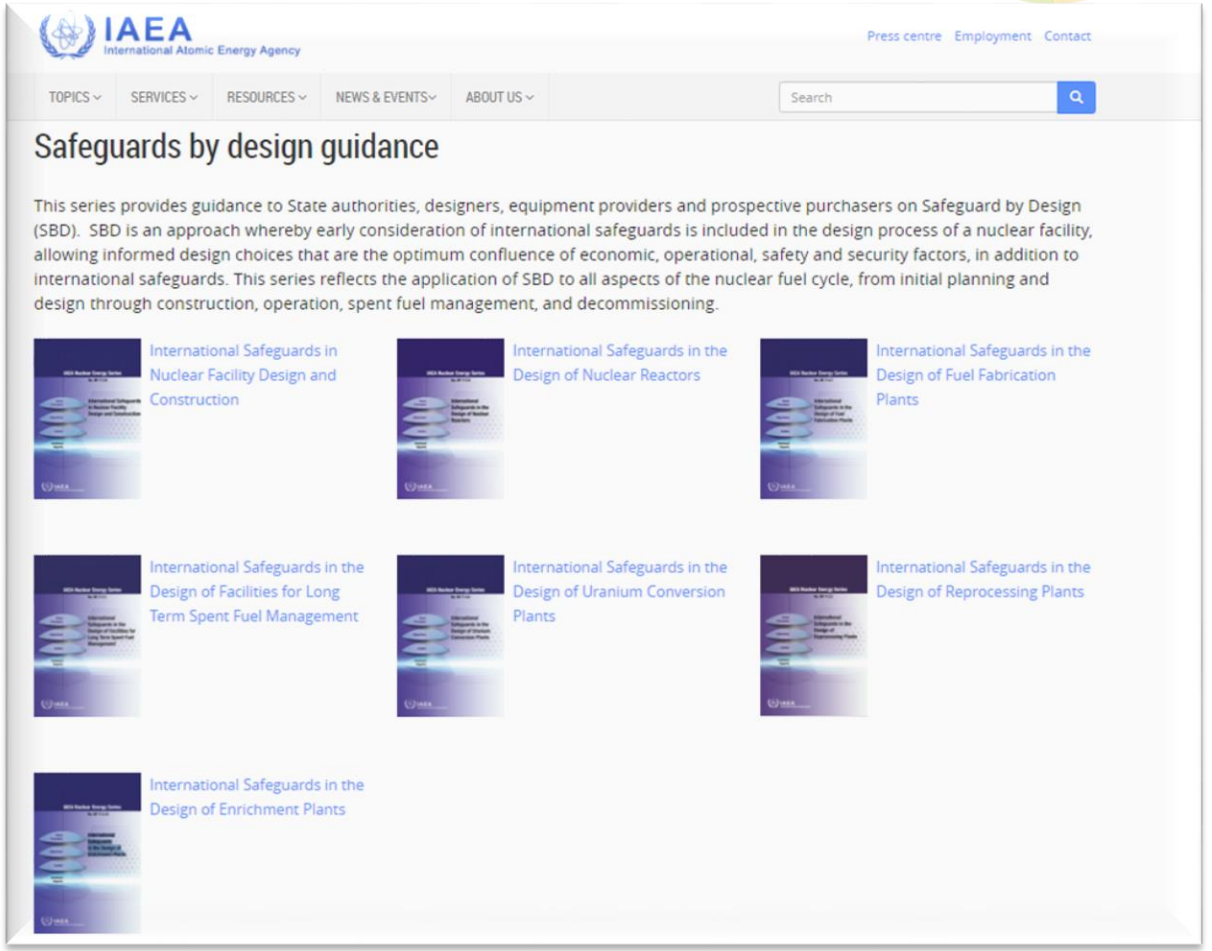
Thank you!

Comparing domestic and international requirements

	Domestic safeguards	IAEA safeguards
Adversary	Malicious insider or outside adversary	State authorities with full cooperation of facility operator
Threat	Unauthorized removal or sabotage of nuclear material	Diversion of nuclear material, undeclared activities
Role of physical protection	Deter, detect, delay, or respond to malicious acts	None
Role of MC&A	• Track material inventories and characteristics • Detect and localize unauthorized removals of nuclear material	• Confirm correctness and completeness of State accountancy declarations • Detect and deter diversion or misuse

General takeaways

- International examples provide informative case studies, but key details for U.S. deployment remain unknown
- **Common themes for IAEA safeguards include: robust C/S, independent redundant measurement capabilities, and authenticated operator data --- *having potentially important interfaces with operator measurement and fuel handling systems***
- Benefits to considering international SG requirements when developing MC&A systems (cost, simplicity, readiness, performance)
- Happy to outreach to other PIs



IAEA guidance on international “safeguards by design”

https://www.iaea.org/topics/assistance-for-states/safeguards-by-design-guidance