ADVANCED REACTOR SAFEGUARDS

Gen-IV PR&PP

*International Interfaces*

PRESENTED BY

Lap Y. Cheng

Advanced Reactor Safeguards Spring Working Group Meeting
May 3-4, 2022
Leveraging International Interfaces to Support ARS

GIF is a framework for international co-operation in research and development for the next generation of nuclear energy systems

- The working group is engaged with IAEA in safety, safeguards, and security (3S).
- ARS supports and leverages GIF PRPPWG activities to
  - Examine safeguards and security aspects of GEN IV systems
  - Evaluate intrinsic/extrinsic features of advanced reactors against proliferation and physical security threats
  - Inform designers and policy makers of research results
  - Facilitate the practice of safeguards and security by design (SSBD)
  - Share experience with vendors interested in international deployment
Recent Accomplishments

• Elected Ben Cipiti to be the 3rd international co-chair of the PRPP Working Group
• Published first two of the PRPP White Papers - LFR & SFR
• Published 2022 edition of the Bibliography
• The SCWR and the GFR white papers will be available soon.

https://www.gen-4.org/gif/jcms/c_9373/publications
In each White Paper an appendix was added to summarize PR relevant intrinsic design features based on IAEA STR-332*:

- Features reducing the attractiveness of the technology for nuclear weapons programs
- Features preventing or inhibiting diversion of nuclear material
- Features preventing or inhibiting undeclared production of direct-use material
- Features facilitating verification, including continuity of knowledge

Super-Critical Water Reactor (SCWR) Design Concepts

- **Russian Federation's Fast-Resonant Spectrum SCWR Core Concept (VVER-SCP-600)**
- **Russian Federation's Mixed-Spectrum SCWR Core Concept (VVER-SKD)**
- **Canada's Pressure-Tube Type SCWR Core Concept**
- **China's Pressure-Vessel Type SCWR Core Concept**
- **EU's Pressure-Vessel Type SCWR Core Concept**
- **Japan's Pressure-Vessel Type SCWR Core Concept**
- **China's Mixed-Spectrum SCWR Core Concept**
- **Japan's Fast-Spectrum SCWR Core Concept**
- **Russian Federation's Fast-Resonant Spectrum SCWR Core Concept (VVER-SCP-600)**
Some Observations of SCWR PR&PP Characteristics

- PR and PP characteristics of SCWRs are closer to the current fleet of light-water reactors (LWRs) than any of the other GEN IV systems.
- There is little distinction between the operation of the vessel and pressure-tube designs; both rely on batch refueling.
- Use of HALEU (High Assay Low Enriched Uranium) and MOX fuel in some designs may require more effort for protection and surveillance.
- Existence of breeding assemblies in some of the fast and mixed-spectrum reactors might need some modification, such as blending them with minor actinides to make them less attractive for diversion.
- For reactors with a thorium fuel cycle, pure U-233 stream available by diverting Pa-233 is not considered a serious vulnerability in the SCWR solid-fuel cores as the fuel removal and reprocessing time would have to be on a very frequent timescale due to the short, 27 day, half-life of Pa-233.
- The separation of the coolant and moderator may have some PP benefit against sabotage in the pressure tube design.
Crosscutting Topics – Compendium Volume

• Fuel Type – Impact of different fuel types and configurations.
• Coolant/Moderator – Impact of different materials in the reactor design.
• Refueling Modes – Impact of refueling differences.
• Small Modular and Microreactor Options – Impact of moving toward smaller designs.
• Fuel Cycle Architecture – Discusses the types of fuel cycles that may be considered.
• Life Cycle – Discusses cradle to grave impacts.
• Flexibility – Discusses differing energy production, load following, and flexible operations.
• Safeguards Topics – Focuses on IAEA safeguards.
• Cyber Threat – Discusses increasing focus on cybersecurity.
• Operational Transparency – Discusses verification of reactor operations.
• Safety – Synergies between safety, security and safeguards.
• Economics – Impact of PR&PP on plant economics.
Next Steps

• Finalize and issue the remaining PR&PP white papers: SCWR, GFR, MSR, VHTR.

• Complete and finalize companion white paper on crosscutting topics, end 2021/beginning 2022.

• Continue collaborate with IAEA, and other GIF working groups with a focus on the 3S integration and special issues related to deployment of SMRs and micro-reactors.
  • Joint project with the GIF Risk & Safety Working Group to explore the interfaces between safety, security and possibly safeguards.
  • Work with the GIF VHTR System Steering Committee to select a system for analysis.

• Outreach to vendors and share results of working group activities.