Sustainable Nuclear Power Initiative

Pacific Northwest
NATIONAL LABORATORY

Proliferation Resistant Technology
Focus Area Fact Sheet

Focus Area Description

The Proliferation Resistant Technology (PRT) Focus Area delivers technological advancements to improve the "safeguardability" of the expanding global nuclear fuel cycle. Preventing fissile material diversion and misuse of facilities that produce and handle nuclear fuels is fundamental to gaining public acceptance of the expanded use of nuclear power in the United States and worldwide.

Heading off latent proliferation risk

Two core elements of today's expanding global nuclear fuel cycle constitute the greatest vulnerability for diversion or misuse of weapons useable nuclear material: uranium enrichment and spent nuclear fuel reprocessing. The enrichment process for making low-enriched uranium fuel for commercial power reactors can be quickly adapted to produce highly-enriched uranium for weapons purposes. In current commercial spent fuel reprocessing, the end products include purified plutonium and uranium, or a mixture of the two – the product is a weapons useable material. As such, the spread of enrichment or reprocessing capability to nations outside the currently existing technology holding States represents a significant increase in latent proliferation risk.

Due to this risk, the United States, other nations, and the Director of the International Atomic Energy Agency (IAEA) have proposed various voluntary trade regime approaches to reduce the spread of enrichment and reprocessing technology to additional nations. These trade regime approaches are known under various names descriptive of a reliable fuel services and supply (RFS&S) regime. Provision of RFS&S by a limited number of technology holding supplier States foresees trade arrangements that assure supply of nuclear fuel and spent fuel disposal services in exchange for voluntary commitments by customer States to refrain from indigenous enrichment and reprocessing programs.

Key safeguards technologies supporting RFS&S approaches include: 1) improvements in the technical safeguards approach on enrichment and reprocessing facilities to account for nuclear material more accurately, 2) the ability to safely manage and safeguard an increasing amount of spent nuclear fuel in interim dry storage around the world and RFS&S related spent fuel shipments, and 3) improvements in the ability to detect and verify noncompliance with nonproliferation undertakings under the IAEA Comprehensive Safeguards Agreements and Additional Protocol. Drawing upon the nuclear heritage of the Hanford site, more than 40 years of radiological R&D expertise and leadership in trace detection technology, PNNL has extensive transferable skills to support development of proliferation resistant technology.

Urenco centrifuge machines.

Science and Technology Capabilities

PNNL's world class expertise in the development of nuclear program signatures detection, specialized security systems, and nonproliferation policy analysis provides an excellent platform for the delivery of new safeguards technologies and approaches to address emerging needs for the proliferation resistant technology mission. Specific PNNL areas of expertise include:

- Radiation detector modeling and design
- Trace actinide chemistry, separations and measurement
- Tamper indicating device engineering
- Integrated system design and prototyping
- Domestic and international nuclear material safeguards policy, regulations, and associated analysis

PNNL capabilities currently support a variety of national security programs for federal clients including radiological monitoring programs for the Department of Homeland Security, Customs and Border Protection, and the National Nuclear Security Administration.

PRT Focus Area Investments

In FY08, PRT Focus Area research is concentrated on eight "proof of concept" R&D projects related to enhancing the safeguarding of the commercial nuclear fuel cycle. Investments include technologies for safeguards at enrichment and reprocessing plants, spent fuel management facilities, nuclear forensics, novel containment and surveillance, and nonproliferation policy and analysis. Results from these proof-of-concept projects will be published in technical journals and presented at leading professional venues, including the Institute of Nuclear Materials Management (INMM).

Enrichment Safeguards

- *UF6 cylinder integrated portal monitor* – conceptual design for an unattended verification instrument for uranium flows in enrichment plants integrating unique cylinder ID, cylinder weight, and average enrichment measurements on cylinders moving in and out of the feed and withdrawal areas. Information automatically updates a plant's electronic "mailbox" declaration.
- *Unattended and timely environmental sampling* – combines an automated aerosol collector with laser spectroscopy techniques for timely sample interrogation and continuous collection of samples for more detailed laboratory analysis.

Reprocessing Safeguards

- *Electrochemical separations cell for enhanced safeguards analysis* – develops a new technique for separating purified microscopic samples of uranium, plutonium, and possibly other transuranics in-situ from process solutions for accurate safeguards accountancy through both drastically simplified laboratory measurements of microscopic grab samples and unattended in-line process monitoring.

Spent fuel from nuclear reactor operations is accumulating worldwide and is safely stored for extended periods in dry storage facilities such as this one. Spent fuel contains significant amounts of plutonium, and is verified under IAEA safeguards.

Verifying Japan's Rokkasho reprocessing plant's declaration represents the largest and most complex IAEA safeguards undertaking at a single facility.

Spent Fuel Safeguards

- *Direct measurement of plutonium and fissile uranium in spent fuel using new non-destructive spectroscopy methods.* Current verification of spent fuel inventory is limited to gross radiation detection, item ID, and review of operator records.
- *Spent fuel shipping and storage cask/vault monitor* – combines radio frequency ID (RFID) technology with GPS, novel tamper indication devices (TID), and other onboard miniature sensors to monitor containment and surveillance (C&S) status and other attributes of spent fuel in transportation and interim dry storage containers.

Nuclear Forensics and Verification

- *Trace metal isotope ratio analysis* – further develops isotope ratio methods for evaluation of reactor total plutonium production history through laboratory evaluation of in-reactor materials.

Novel Containment and Surveillance Technology

- *Tamper resistant container coatings* – develops a method for coating standard IAEA tamper resistant containers with an optically stimulated luminescent (OSL) coating which can quickly reveal breeches in container integrity even in the absence of visible indications of tampering.

Nonproliferation Policy and Analysis

- *Expert Elicitation Process for Evaluation of Proliferation Resistance of Nuclear Energy Systems* – develops a practical and graded approach to evaluation of the "proliferation resistance" for nonproliferation policy makers and designers of nuclear technology.

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