



## Background

In December 2002, the DOE Office of Nuclear Energy, Science and Technology (NE), in partnership with the Generation IV International Forum (GIF), developed “A Technology Roadmap for Generation IV Nuclear Energy Systems”. This roadmap established proliferation resistance and physical protection goals (PR&PP) for the Generation IV concept technologies. The National Nuclear Security Administration (NNSA) participated as a nonproliferation advisor to the Evaluation Methodology Group of the Generation IV Roadmap. In February 2002, the NNSA Nonproliferation Assessment Methodology (NPAM) Working Group began their efforts to produce a document entitled “Guidelines for Nonproliferation Analysis.” This document was issued by NNSA in 2003. As these projects neared completion, it was evident that additional work was required in support of proliferation resistance assessment methodology development, and that the interested organizations, along with international participants, decided to work together to achieve this.

DOE-NE took the initiative to create an Expert Group under the auspices of the Generation IV International Forum (GIF) for the development of the PR&PP assessment methodology. With the shared interest of NNSA, and as a continuation of the NPAM activities, DOE-NE and NNSA agreed to jointly fund the U.S. participation in the PR&PP Expert Group. To date, in addition to the U.S., the following GIF members are participants in the group: Canada, France, Japan, Republic of Korea, United Kingdom, and Euratom. In addition, the IAEA has been an active participant in the group.

The NNSA contribution to these activities is to enable formulation of policy to minimize the use of weapons-useable materials and to identify opportunities to reduce the proliferation risk in civil fuel cycle activities. Ultimately, the aim is to increase the assurance that new nuclear fuel cycle systems are an increasingly undesirable route for diversion or theft of weapons-useable materials and that they provide

increased safeguards and physical protection over existing fuel cycle facilities.

## Mission and Goals

The mission of the PR&PP activity is to develop a systematic method that will evaluate and compare proliferation resistance and physical protection of Generation IV nuclear energy systems, including their fuel cycle facilities and operations. PR&PP was established in December 2002 and will continue through FY 2006. The international Experts Group decided on a scenario-based approach to assessing vulnerabilities to proliferation resistance and physical protection (see Figure 1). Threats, system response, and evaluation of outcomes are essential elements of the approach. The threat elements of proliferation resistance to be considered are shown in the accompanying text box.

### *Proliferation Resistance Threat Elements*

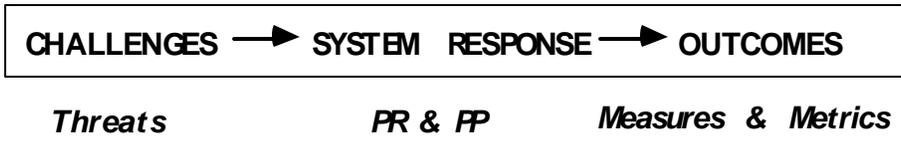
The Proliferation Resistance of a fuel cycle system is determined by its ability to counter the following threats:

- Diversion of material from declared flows and inventories/concealment.
- Facility misuse: undeclared production in declared facilities/concealment.
- Clandestine replication of declared equipment or facilities or use in a separate clandestine program.
- Use following abrogation of nonproliferation commitments: impact of Generation IV systems on a State’s capability to acquire weapons-useable material, facilities and equipment for a weapons program following abrogation of the Treaty on the Non-proliferation of Nuclear Weapons (NPT) and related agreements.

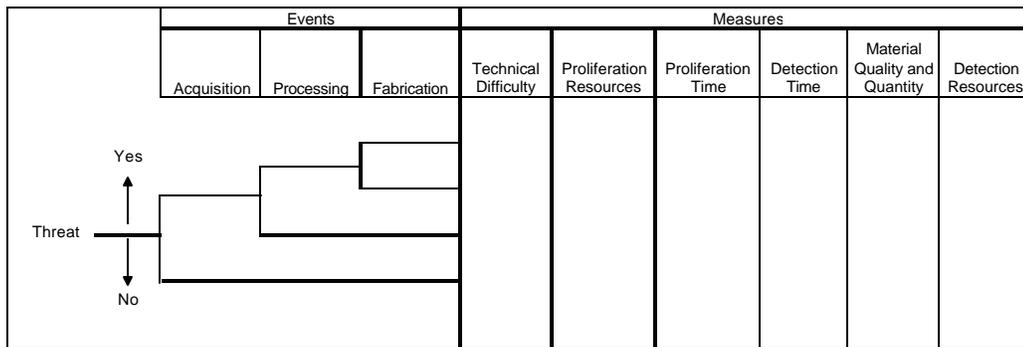
**Physical Protection**

- Theft of weapons-usable material from fuel cycle facilities or transport systems.
- Acquisition of hazardous radioactive material from nuclear installations for use in a dispersion weapon (radioactive dispersal device or dirty bomb).
- Sabotage (internal or external) at a nuclear facility with the intention to release radioactive material to harm the public, damage the facility, or disrupt its operations. Sabotage of transport systems carrying radioactive material used in the Generation IV system with the intention to release radioactive material to harm the public.

A first version of the evaluation methodology was issued as a report in January 2004. Figure 2 illustrates a functional event tree for proliferation resistance. The outcomes (measures) to be evaluated are also indicated in this figure. The goal for FY04 is to conduct an initial developmental study and to further refine the methodology. The system chosen for this developmental study is an “example sodium fast reactor.” In FY05, based on results of the developmental study, the methodology will be refined and then applied to a representative Generation-IV type model. In FY06, the Experts Group will collaborate with the Generation IV concept development teams to perform specific PR&PP assessments of Generation IV systems.



**Figure 1.** Framework for PR&PP Assessment.



**Figure 2.** Functional Event Tree for Proliferation Resistance.

**International Cooperation**

The IAEA has a standard (INFCIRC/225.Rev.4) for physical protection, which has been incorporated into PR&PP. The Generation IV PR&PP and the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) have jointly developed a definition of “proliferation resistance” shown in the text box.

- **Proliferation Resistance** is that characteristic of a nuclear energy system that impedes the diversion or undeclared production of nuclear material, or misuse of technology, by the host State in order to acquire nuclear weapons or other nuclear explosive devices.
- **Physical Protection** is that characteristic of a nuclear energy system that impedes the theft of materials suitable for nuclear explosives or radiation dispersal devices, and the sabotage of facilities and transportation, by sub-national entities and other non-host State adversaries.