

Issues for Proliferation Resistance and Physical Protection (PR&PP)

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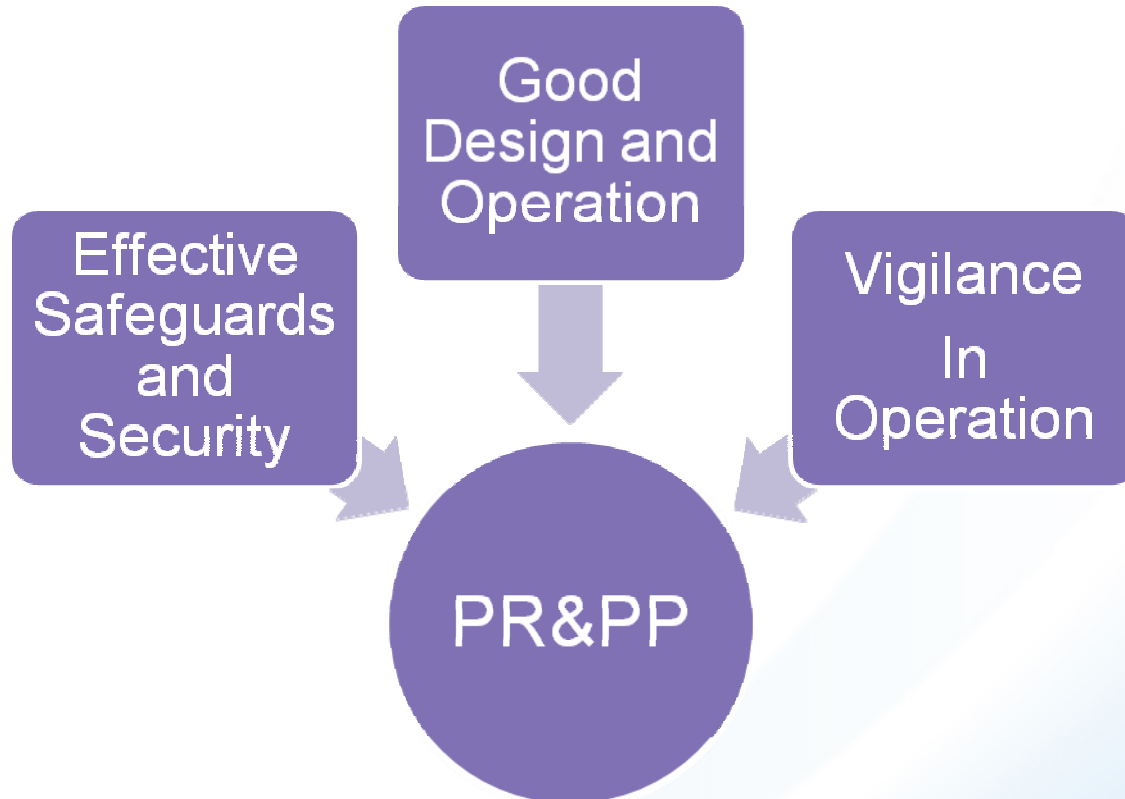
a passion for discovery



Purpose of PR&PP Evaluations

- *To introduce PR&PP features into the design process at the earliest possible stage of concept development*
- *Both the intrinsic (physical and engineering) and extrinsic (safeguards and institutional arrangements) characteristics can benefit from incorporating PR&PP risk reduction into considerations of the design*
- *While only the most general features of the design are known initially, PR&PP concepts can help to manage risk reduction*
- *As the design matures, increasing detail can be incorporated in the PR&PP model of the system: progressive refinement*
- *PR&PP results also an aid to informing decisions by policy makers*

Key Elements of PR&PP



Issues for PR&PP

- How to characterize and measure it
- How to evaluate it
- How to express it
- How to manage it (in nuclear energy systems)
- How to communicate it
- How well is it characterized today?
- Managing multiple objectives
- Comprehensive vs. focused evaluations

Current Programs

- International
 - Generation IV International Forum
 - IAEA INPRO Program

- National

- Multilateral programs

- Special focus

Technology Goals for Generation IV

- Sustainable Nuclear Energy
- Competitive Nuclear Energy
- Safe and Reliable Systems
- Proliferation Resistance and Physical Protection

Generation IV International Forum (GIF) PR&PP Sponsors and Liaisons

- Generation IV International Forum
 - Canada
 - European Commission
 - France
 - Japan
 - Republic of Korea
 - United Kingdom (initially)
 - United States

- Liaisons: IAEA, USDOS, USNRC, other DOE Labs

- USA Sponsors
 - DOE/NE-33
 - NNSA/NA-243

PR & PP Comparison/Distinctions

Proliferation Resistance

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

Physical Protection

- Sub-national is adversary
- Threats are
 - Theft
 - Sabotage
- Fast moving events
(sometimes)

Measures

Physical Protection

- Adversary Success Probability
- Consequence
- Cost of Protection

Proliferation Resistance

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

PR&PP Methodology

CHALLENGES



SYSTEM RESPONSE



OUTCOMES

Threats

PR

- Diversion/misuse
- Abrogation
- Clandestine facility

PP

- Theft
- Sabotage

PR & PP

Intrinsic

- Physical & technical design features

Extrinsic

- Institutional arrangements

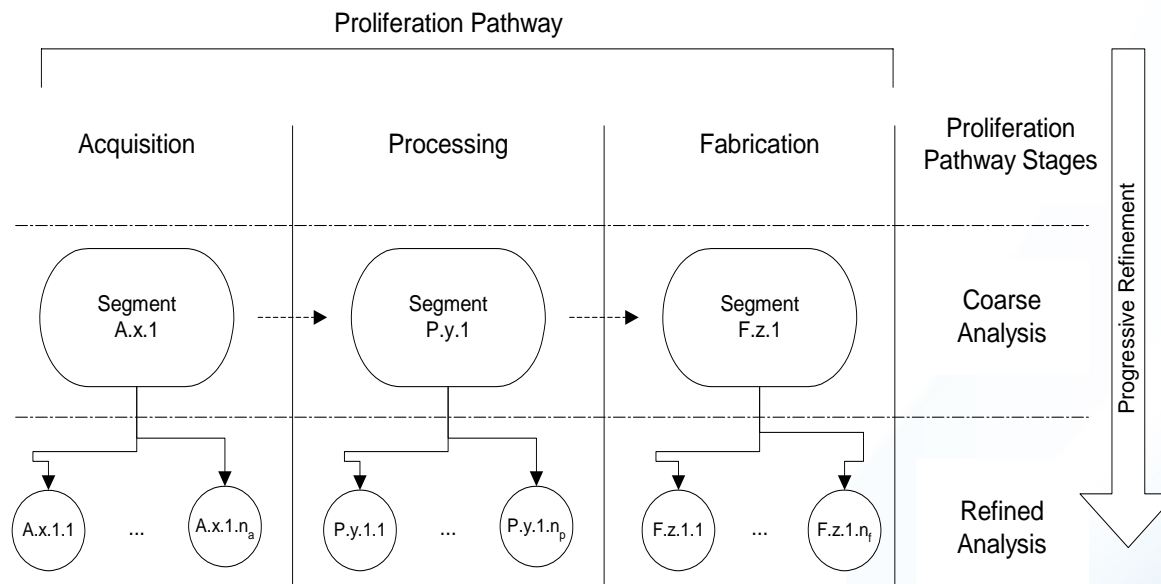
Assessment

Measures and Metrics

Paradigm is consistent with standard approaches to safety assessment

Methodology Report: <http://www.gen-4.org/Technology/horizontal/PRPPEM.pdf>

Progressive Refinement of Evaluation



Safeguardability: PR&PP Rev. 5, App.D

Definition:

The degree of ease with which a system can be effectively and efficiently put under international Safeguards

Objectives:

- To provide an alternative to the quantitative estimation of the Detection Probability (DP) and Detection Resources Efficiency (DE) measures where not enough information about the implemented Safeguards approach are available;
- To provide system designers with a list of attributes to be taken into account at very early design stages in order to facilitate the implementation of International Safeguards (Guide words/Check list type approach).

Harmonization of PR&PP with INPRO

Objective

- To identify areas of synergies and where the methodologies may complement one another
- To identify potential users of proliferation resistance assessment methodologies and their information needs
- To give guidance for interpretation of results, propose methods of presentation of results to users

Progress

- Correspondence between INPRO User Requirements (Urs) and Gen IV Measures for PR&PP now established
- Establishing how different users are informed by URs and Measures

PR&PP / INPRO Comparison

	<i>INPRO (PR)</i>	<i>PR&PP</i>
Client	All countries interested in innovative nuclear energy systems	GEN IV
Purpose	Evaluation of system design against INPRO requirements	Quantitative assessment of the proliferation resistance of a nuclear system.
Evaluation Approach	Criteria (Indicators + Acceptance Limits) > User Requirements	Threat > System Response > Outcome
Analysis Inputs	State specific conditions, system design, acquisition path	System design, safeguards design, acquisition path
Outputs of Analysis/Evaluation	Requirements compliance/gaps; needs for R&D	System assessment; pathway comparison; needs for R&D
Users of Results	Developers/designers, policy makers	Developers/designers, policy makers

PR&PP and Safety

Safety

- Threats are accidents
- Inherent Features and Engineered Systems Provide Safety
- Defense in depth and safety margins are universally embraced
- Risk models aid in managing safety improvement

PR&PP

- Threats are deliberate
- Intrinsic and Extrinsic Characteristics Provide Robustness
- Multiple barriers and acceptable figures of merit can be useful guides
- Need for development of workable risk models

Some Observations and Insights

- Use of multiple pathways/scenarios highlights fact there are no simple answers
 - “Threat” is disaggregated into host-state and non-state
 - Results are scenario-specific
 - Results sensitive to underlying assumptions about existing capabilities and objectives of adversaries
 - Validates decision not to roll up analysis into a single figure of merit
 - Interface of extrinsic and intrinsic measures—“safeguardability” a key consideration
- PR&PP evaluation provides valuable feedback to system design
 - Types of targets being created – minimize attractiveness of material
 - Physical arrangement – place potential targets into the correct types of locations to facilitate physical protection and safeguards monitoring

Upcoming PR&PP WG Activities

- Workshop with Gen IV design representatives in July 2009
- Case Study Report on example full fuel cycle system complete
 - **Final draft of report to be submitted shortly to GIF**
- Multiple sessions on PR&PP methods and applications at Global 2009
 - Plan to develop papers for special issue of a scientific journal
- Participation in GIF Symposium, September, 2009
- Papers at INMM Annual Meeting, July 2009
- Work beyond 2009
 - **Continue interactions with system design groups**
 - **Cooperate with various groups on advanced safeguards**
 - **Update methodology in 2010 (include revised metrics)**

Final Note

- *It is the insights gained from the disciplined process of performing the evaluation that is of value, and not just the final results.*
- *Seek benefits of PR&PP evaluations early in the design process.*