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Proliferation Resistance and Physical Protection (PR&PP) Evaluation Methodology: Objectives, Accomplishments, and Future Directions

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Abstract – *We present an overview of the objectives, accomplishments, and potential future directions of the program on the evaluation methodology for proliferation resistance and physical protection (PR&PP) of advanced nuclear energy systems. We intend the results of the evaluations performed with the methodology for three types of users: system designers, program policy makers, and external stakeholders. The PR&PP Working Group developed the methodology through a series of demonstration and case studies. Over the past few years various national and international groups have applied the methodology to nuclear energy system design as well as to developing approaches to advanced safeguards. We suggest some future applications of the methodology in this paper.*

I. INTRODUCTION

We present an overview of the objectives, accomplishments, and potential future activities of the program on the evaluation methodology for proliferation resistance and physical protection (PR&PP) of advanced nuclear energy systems (NESs). The Generation IV Roadmap[1] recommended the development of an evaluation methodology to define measures for PR&PP and to develop a methodology for evaluating them for the six NESs proposed within the Generation IV program. Accordingly, the Generation IV International Forum (GIF) formed a Working Group in December 2002 to develop a methodology. GIF approved the current version of the methodology (Revision 5) for open distribution and it is available at the GIF website[2].

For a proposed NES design, the methodology defines a set of challenges, analyzes system response to these challenges, and assesses outcomes. The challenges to the NES are the threats posed by potential actors (proliferant States or sub-national adversaries). The characteristics of Generation IV systems, both technical and institutional, are used to evaluate the response of the system and to determine its resistance against proliferation threats and robustness against sabotage and terrorism threats. The outcomes of the system response are expressed in terms of a set of measures, which are the high-level PR&PP characteristics of the NES. The methodology is organized to allow evaluations to be performed at the earliest stages of system design and to become more detailed and more representative as the design progresses. It can thus be used to enable a program in safeguards by design or to enhance the conceptual design process of an NES with regard to intrinsic features for PR&PP. We intend the results for three types of users: system designers, program policy makers, and external stakeholders.

II. OBJECTIVES

The Technology Goals for Generation IV NESs highlight PR&PP as one of the four goal areas along with Sustainability, Safety and Reliability, and Economics:

> *Generation IV nuclear energy systems will increase the assurance that they are a very unattractive and the least desirable route for diversion or theft of weapons-usable materials, and provide increased physical protection against acts of terrorism.*

We define PR&PP as follows.

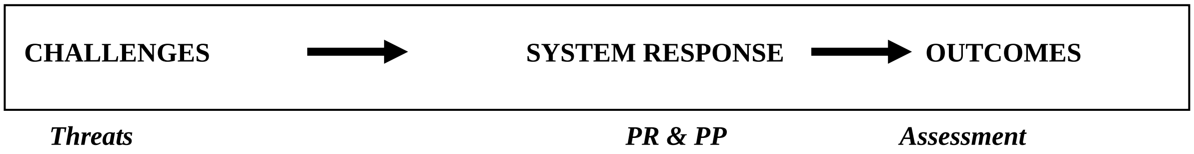
Proliferation resistance is that characteristic of an NES that impedes the diversion or undeclared production of nuclear material or misuse of technology by the Host State seeking to acquire nuclear weapons or other nuclear explosive devices.

Physical protection (robustness) is that characteristic of an NES that impedes the theft of materials suitable for nuclear explosives or radiation dispersal devices (RDDs) and the sabotage of facilities and transportation by sub-national entities and other non-Host State adversaries.

According to the current Terms of Reference approved by GIF, the responsibilities of the PR&PP Working Group (WG) are as follows:

- Maintain cognizance of PR&PP evaluations conducted under the auspices of GIF or with the knowledge and counsel of GIF through its member states, and serve as a clearinghouse for advice to the GIF Policy and Experts Groups on PR&PP issues related to Generation IV NESs;
- Monitor the integrity and quality of evaluations conducted under the auspices of GIF or with the knowledge and counsel of GIF through its member states under terms and conditions that protect proliferation-sensitive and proprietary information, provide peer-review of PR&PP evaluations upon request, and address questions related to the fidelity with which the methodology is applied;
- Maintain configuration control over the PR&PP methodology, its documentation and revisions, and serve as a central authority to review and accept methodology improvements and incorporate them in the configuration-controlled GIF PR&PP methodology;
- Strengthen the link with Generation IV system designers, in particular with GIF System Steering Committees;
- Maintain cognizance of and interactions with other GIF-related activities, such as the Risk and Safety Working Group;
- Maintain cognizance of and interactions with non-GIF activities such as IAEA initiatives and specific national initiatives;
- Promote and facilitate early consideration of PR&PP in the development and design of Generation IV systems;
- Promote PR&PP goals and broad acceptance of the PR&PP methodology by participation in conferences and publication of papers;
- Maintain capability to perform or direct PR&PP studies on request of GIF.

The diagram shown here illustrates the methodological approach at its most basic. As noted in the Introduction, for a given system, analysts define a set of ***challenges***, analyze ***system response*** to these challenges, and assess ***outcomes***.



The evaluation methodology assumes that an NES has been at least conceptualized or designed, including both the intrinsic and extrinsic protective features of the system. Intrinsic features include the physical and engineering aspects of the system; extrinsic features include institutional aspects such as safeguards and external barriers. A major thrust of the PR&PP evaluation is to elucidate the interactions between the intrinsic and the extrinsic features, study their interplay, and then guide the path toward an optimized design.

The structure for the PR&PP evaluation can be applied to the entire fuel cycle or to portions of an NES. The methodology is organized as a *progressive* approach to allow evaluations to become more detailed and more representative as system design progresses. PR&PP evaluations should be performed at the earliest stages of design when flow diagrams are first developed in order to systematically integrate proliferation resistance and physical protection robustness into the designs of Generation IV NESs along with the other high-level technology goals of sustainability, safety and reliability, and economics. This approach provides early, useful feedback to designers, program policy makers, and external stakeholders from basic process selection (e.g., recycling process and type of fuel), to detailed layout of equipment and structures, to facility demonstration testing.

III. RECENT ACCOMPLISHMENTS

The PR&PP WG has recently performed a case study on an example sodium fast reactor (ESFR) and its associated fuel cycle to exercise the methodology and to obtain preliminary insights on the PR&PP aspects of this system[3]. The is also an ongoing effort[4] to seek harmonization between the PR&PP methodology and an initiative by the International Atomic Energy Agency (IAEA) on a related approach to proliferation resistance that has been developed under the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO). The purpose of this harmonization activity is to more fully understand and articulate the range of applicability and the potential for appropriate synergy and cooperation among the two efforts. Further, the PR&PP WG and the System Steering Committees (SSCs) for each of the six design concepts within GIF have undertaken a focused effort integrate PR&PP notions into the design activities for each of the six concepts.

Example Sodium Fast Reactor Case Study

The PR&PP WG has developed its methodology with the aid of a series of studies. The ESFR consists of four sodium-cooled fast reactors of medium size co-located with an on-site dry fuel storage facility and a pyrochemical spent fuel reprocessing facility.

The objectives of the Case Study were to exercise the GIF PR&PP methodology for a complete Gen-IV reactor/fuel cycle system; to demonstrate, via the comparison of different design options, that the methodology can generate meaningful results for designers and decision makers; to provide examples of PR&PP evaluations for future users; to facilitate transition to other studies; and to facilitate other ongoing collaborative efforts (e.g., INPRO) and other national efforts

We explain how the Case Study met these goals. In fact, there are lessons learned pertaining to all the ESFR Studies' objectives:

- Lessons of the initial 2004 Development Study primarily set the form of the methodology
- Lessons of the 2006 Demonstration Study dealt with the process of organizing and managing a PR&PP evaluation
- Lessons of the current Case Study involved improving and structuring the evaluation process and advancing the methodology. For PR, the lessons have clarified the relationships among diversion, misuse, and breakout.

Lessons learned were that each PR&PP evaluation should start with a qualitative analysis allowing scoping of the study, of the assumed threats and identification of targets, system elements, etc.; that there is a need to include detailed guidance for qualitative analyses in methodology; that the role of experts is essential; that there is a need for PR and PP experts and expert elicitation techniques; and that qualitative analysis offers valuable results, even at the preliminary design level. Qualitative analysis can directly address the measures for PR: Technical Difficulty (TD), Proliferation Time (PT), Proliferation Cost (PC), and Material Type (MT). However, Detection Resource Efficiency (DE) and especially Detection Probability (DP) are harder to quantify using qualitative analysis.

Systematic identification of potential diversion pathways is a key goal. We found that it is possible to systematically identify targets and potential pathways for each specific threat, and to systematically search for plausible scenarios that could implement the potential proliferant Host State's strategies to divert the target material. A set of diversion pathway segments were developed and the proliferation resistance measures for each pathway were determined. The methodology compares and distinguishes how different design choices affect proliferation resistance.

The diversion pathways analysis provides a variety of useful information to stakeholders, including regulatory authorities, government officials, and system designers. This information includes how attractive the material is to potential proliferators for use in a weapons program; how difficult it would be to physically access and remove the material; and whether the facility can be designed and operated in such a manner that all plausible acquisition paths are impeded by a combination of intrinsic features and extrinsic measures.

The misuse pathways analysis requires consideration of potentially complex combinations of processes to produce weapons-usable material, i.e., it is not a single action on a single piece of equipment, but rather an integrated exploitation of various assets and system elements. We found that, given a proliferation strategy, some measures are likely to dominate over the others, and within a measure some segments will dominate the overall pathway estimate.

The breakout pathways analysis found that breakout is a *modifying strategy* within the diversion and misuse threats and can take various forms that depend upon intent and aggressiveness, and ultimately the proliferation time assumed by a proliferant state. Furthermore, measures can be assessed differently within the breakout threat, depending upon the breakout strategy chosen. Some additional factors related to global response and foreign policy were identified as being relevant to the breakout threat, but those factors are not included in the PR&PP methodology.

The theft and sabotage pathways analysis found that multiple target and pathways exist. The most attractive theft target materials appeared to be located in a few target areas. Specifically, for the ESFR, the most attractive theft target areas with the most attractive target materials were found to be the LWR spent fuel cask parking area, the LWR spent fuel storage and fuel cycle facility staging/washing area, the fuel cycle facility air cell (hot cell), and the inert hot cell.

As noted in the PR&PP methodology report[2], a substantial base of analytic tools already exists for theft and sabotage pathway analysis. The case study verified that these tools can be used within the paradigm of the PR&PP methodology.

Proliferation Resistance Lessons. Structured qualitative analysis can produce traceable, accountable, and dependable results providing useful information to system designers, even when detailed design information is largely missing (e.g., by introducing reasonable design assumptions that are documented and become functional requirements). It is often possible to identify small differences in the rationale that are reflected in the measure estimates.

It has been possible to provide traceability in the analysis outcomes, via the explicit recording of the evidence upon which the estimates and judgments were made. This enables the possibility of a thorough review of the analysis results, building confidence about the dependability and accountability of the outcomes. It was observed that breakout strategies may be changing, as political stresses evolve.

We note that every technical system (NES) is embedded in an institutional system (State owning it and operator running it, inspectors checking it, etc.), which in its turn is placed within a given context (political situation, crisis vs. non crisis scenarios, etc.). The overall proliferation resistance of a NES comes from the interaction of these systems, and therefore it is not just an intrinsic characteristic of an engineering asset.

Technical difficulty is an intrinsic measure in the sense that no matter which institutional system and context we are dealing with, the would-be proliferator will have to make technical modifications to the system to reach his goals. Depending on the scenario these modifications might be less or more in both quantity (e.g., concealment or not) and effectiveness (e.g., technologically advanced country or not). Detection probability on the other hand is considered to be an extrinsic measure because it is a barrier only in given contexts; for example, a system where no inspections are foreseen (or allowed) could not count on this aspect as a deterrent.

Physical Protection Lessons. While containment of the adversary is adequate for theft, for sabotage, a deterrence strategy that prevents adversary access to targets is required. Given the proximity of theft and sabotage targets in the ESFR facility, it appears that the ESFR will require a deterrence strategy, because the Physical Protection System will not be able to determine the adversary intent, i.e., theft or sabotage, early enough. This will require a robust perimeter detection system and effective use of the passive barriers provided by hot cell radiation shielding structures and by reactor passive safety systems. For theft and sabotage scenarios where early detection probability is low, the response force time has the greatest impact on adversary success. For theft and sabotage scenarios where early detection probability is high, the probability of adversary success decreases rapidly as the response times become shorter.

The Case Study indicated that the methodology could be improved by:

- Applying the measures to a broader range of targets and pathways to gain additional experience with their practical application,
- Investigating the specific form of the metrics used to express the measures.

Interactions with Nuclear Energy System Designers

As part of the effort to familiarize GIF participants with the PR&PP methodology, particularly system designers and program policy makers and to better understand the needs of the designers, a series of workshops were held beginning in the US in 2005, Italy in 2006, Japan in 2007, and Republic of Korea in 2008. Useful mutual information exchange occurred during these workshops which helped to further define the methodological approach and the needs of the users.

Also, in 2007 informal discussions began between the PR&PP WG and representatives of the GIF SSCs for each of the six Gen IV design concepts on the exploration of ways that the two entities could cooperatively pursue joint projects. A workshop of interested parties was held in May 2008 at Brookhaven National Laboratory which resulted in a program plan for future joint activities. Three broad goals were defined for future joint activities: (1) identify in the near term salient features of the design concepts that impact their PR&PP performance, (2) perform crosscutting studies that assess against PR&PP criteria design or operating features common to various Gen IV systems, and (3) infer functional requirements for the global layout of future nuclear energy systems. See paper by F. Carre and S. Felix, these Proceedings, for further details [5].

As of this writing, draft white papers on the PR&PP aspects and issues each of the six design concepts are in development between representatives of the SSCs and the PR&PP WG. A follow-on workshop is planned for July 2009 to further advance the white papers and to continue future joint activities.

Interactions with GIF RSWG

In addition to the establishment of the PR&PP WG, the GIF has recognized the need for a Risk and Safety Working Group (RSWG) to address the approach to be adapted to safety of future nuclear energy systems. The GIF also recognized that an interface with the activities of the PR&PP WG would be needed, and thus noted:

- A need for integrated consideration of safety, reliability, proliferation resistance and physical

protection approaches in order to optimize their effects and minimize potential conflicts between approaches.
- A need for mutual understanding of safety priorities and their implementation in PR&PP and RSWG evaluation methodologies.

The efforts of these two groups continue to be carefully coordinated. This has been largely accomplished so far via the close working relations between the leaderships of the two groups. Advances by either group have relevance to the other and are mutually beneficial to both. It also continues to be important to assess and understand the impact of all specific design features in relation to objectives of safety performance, physical protection, and proliferation resistance.

Topics for further discussion relative to PR&PP and RSWG collaboration include:

1. An integrating framework that would embrace both RSWG and PR&PP methods and concepts.
2. Elements of the evaluation methodologies and how they can be mutually supportive and consistent.
3. The use of specific examples: PR&PP initially selected a sodium fast reactor; the RSWG might also focus on this system providing insights based on the technology neutral approach which would be duly developed to address the ESFR specificities.
4. Vehicles and means for sharing and applying concepts and methods in support of evolving Generation IV system designs.

See Khalil et al, Proceeding of this conference for further details[6].

Proliferation Risk Reduction Assessments

In January 2009, the U.S. Department of Energy (DOE) National Nuclear Security Administration (NNSA) released a draft Non-Proliferation Impact Assessment (NPIA) of the Global Nuclear Energy Partnership (GNEP) for public comment[7]. The draft NPIA analyzes the U.S. domestic nuclear fuel alternatives identified in the draft GNEP Programmatic Environmental Impact Statement (PEIS) for their potential impacts on the risk of nuclear proliferation and on U.S. nonproliferation goals. For details on the PEIS see http://nuclear.gov/peis.html.

GNEP started as an initiative by the U.S. DOE to offer a framework for world-wide use of nuclear power while reducing the risks of nuclear proliferation and the impacts of radioactive waste. The GNEP PEIS addresses the environmental impacts of U.S. domestic fuel cycle choices, including possibly closing the nuclear fuel cycle; the NPIA addresses the nonproliferation impacts of those same choices.

In evaluating the proliferation risk associated with the GNEP fuel cycle alternatives, the NPIA considered both policy and technical factors[8]. The policy evaluation drew on the relevant objectives of U.S. policy, which include discouraging the spread of enrichment and reprocessing technology, minimizing stocks of separated plutonium, promoting proliferation resistant technology, and improving international safeguards. The technical evaluation drew on the PR&PP methodology[2]. The draft NPIA concluded that recycling of spent fuel may offer opportunities for the United States to discourage the spread of enrichment and reprocessing technologies by participating in comprehensive nuclear fuel services. However, the NPIA also noted that, by separating relatively attractive materials from spent fuel, such recycling also involves new risks compared to the current once-through fuel cycle.

Other proliferation risk reduction studies are currently underway under the sponsorship of the NNSA. These relate to the comparative PR&PP performance of various advanced reactor concepts. Results of these studies will be under review and may be disseminated broadly at a later date.

An Element of the Next Generation Safeguards Initiative (NGSI)

International safeguards are a central pillar of the nuclear nonproliferation regime. Administered by the IAEA, international safeguards serve to monitor nuclear activities under the Non-Proliferation Treaty (NPT) and are the primary vehicle for verifying compliance with peaceful use and nuclear nonproliferation undertakings.

The DOE’s NNSA undertook a broad review of international safeguards, which concluded that a comprehensive initiative to revitalize the international safeguards technology and human resource base by leveraging U.S. technical assets and partnerships was urgently needed to keep pace with demands and emerging safeguards challenges.

To address these challenges, NNSA launched the NGSI[9] to develop the policies, concepts, technologies, expertise, and infrastructure necessary to sustain the international safeguards system as its mission evolves over the next 25 years. NGSI is designed to revitalize and strengthen the U.S. safeguards technical base, recognizing that without a robust program the United States will not be in a position to provide the necessary support to the safeguards regime. The initiative will also bring together international partners to join forces in meeting key safeguards challenges.

The deployment of new types of reactors and fuel cycle facilities, combined with the need to make the most effective and efficient use of limited safeguards resources, requires new concepts and approaches. NGSI will address this challenge by applying a system-level approach to safeguards and by promoting “Safeguards by Design” as an international standard. The program plan for the NGSI calls for using the PR&PP methodology to evaluate new nuclear system designs for proliferation risk reduction. This will be helpful in establishing a global norm for designers to systematically identify tradeoffs and evaluate and compare different options. At the same time the methodology applications would have to be of sufficient quality to avoid unwarranted reductions in safeguards and physical protection efforts

Safeguards by Design

There are ongoing and planned efforts both nationally[9] and internationally[10] to promote and implement the concept of safeguards by design (SBD) in the nuclear facility design process. The goals of an SBD program are to generally consider: (1) design principles that facilitate the effective implementation of safeguards without overly burdening facility operations staff, (2) cost saving measures for implementing safeguards, (3) facility design features that would improve inspection conditions as compared to present standards, (4) better understanding among facility designers of safeguards principles, and (5) information exchange on advancements in safeguards technologies. Further, assessments of the benefits of SBD need to fit into the broader proliferation resistance framework. This is because, a gauge for how much proliferation risk reduction is being achieved in a SBD activity is needed to be able understand its relative value with regard to economic, operational, safety, and security factors. Without the overarching framework it would be difficult to judge how to improve safeguards in the design.

Towards Harmonization with INPRO

In parallel with the multilateral effort by GIF PR&PP WG, and over the same time period, the IAEA has been sponsoring development of an International Project on INPRO to help to ensure that nuclear energy is available in the 21st century in a sustainable manner. See Pomeroy et al[5] for additional information. In particular, INPRO has put forth basic principles, user requirements, and criteria for future nuclear energy systems, with similar broad goal areas to those that are being considered by GIF, including proliferation resistance and physical protection.

The INPRO approach[11] is primarily designed for nuclear energy system *users* (and thus guides the INPRO assessor in confirming that adequate proliferation resistance has been achieved in the NES under consideration), but it can also give guidance to the *developer* of nuclear technology on how to improve proliferation resistance. The INPRO proliferation resistance approach identifies a *Basic Principle of Proliferation Resistance* and five *User Requirements* for meeting this Principle, along with seventeen indicators with specific criteria and acceptance limits.

The approaches share certain similarities, beginning with a common definition of proliferation resistance. Both approaches have a hierarchal analytical structure involving proliferation resistance principles, high-level evaluation factors and multiple measures or criteria related to each high-level factor. Both approaches treat proliferation resistance as a function of multiple *extrinsic measures* (e.g., safeguards, etc.) and *intrinsic features* (e.g., material attractiveness, etc.), and characterize proliferation resistance in terms of each. Both approaches recognize the concept of *barriers* to proliferation, but implement the concept differently. Neither approach aggregates its results into a single numerical value or grade, so that strengths and weaknesses under each of the main evaluation criteria are explicitly considered. Both approaches are primarily technical evaluations that incorporate institutional and policy contexts for the systems under consideration.

There are several notable differences between the two approaches. The INPRO approach focuses on the proliferation resistance of a declared, safeguarded nuclear energy system in a specific State, and implicitly excludes from the analysis clandestine facilities (including those that might be needed to complete a proliferation pathway) or a breakout scenario (in which a facility is *overtly* misused for proliferation purposes). In comparison, the GIF approach considers both declared and undeclared facilities and activities, to complete the proliferation pathway from acquisition and processing of material to fabrication of a nuclear explosive device as well as overt misuse following breakout.

INPRO examines the whole system, sets explicit User Requirements, and asks how the system meets these User Requirements. In particular, INPRO explicitly takes into account a State’s nonproliferation commitments and agreements in one of its User Requirements (UR1). In the GIF approach, these commitments are treated implicitly in estimating the GIF *detection probability* measure of a segment or of a pathway. The GIF approach lends itself to comparing the relative proliferation resistance of different nuclear energy systems. A GIF analysis involves separation of a system into components (system elements) and performing a pathway analysis that provides the basis for a proliferation resistance evaluation.

There are areas in which one method can productively be used in conjunction with the other. For example, User Requirement IV of the INPRO methodology stipulates that there should be both *multiple* and *robust* barriers to proliferation for each reasonable proliferation pathway. However, the INPRO method does not describe how the robustness of these barriers should be evaluated. The GIF pathway approach is well-suited to conduct such evaluations; however, a means must be developed that allows an effective interface between the two approaches at this level (for example, compatibility of the INPRO evaluation parameters and GIF metrics must be examined). One of the next steps in this process is to demonstrate how information about the proliferation resistance of nuclear energy systems, including an understanding of relevant strengths and vulnerabilities of a system using either the INPRO or GIF proliferation resistance approach, can be effectively interpreted and communicated to those who need this information.

As noted in Reference [5], over the next few years, important contributions of proliferation resistance assessment will be (1) demonstrating the complexity of proliferation resistance and strengths and weaknesses of the concept and the methodologies, (2) characterizing the relative proliferation resistance risk of proposed fuel cycle systems and facilities, (3) reinforcing the importance of incorporating effective safeguards and barriers to diversion of nuclear materials into the design of new facilities, from the pre-conceptual design stage onwards, and (4) incorporating proliferation resistance in decision-making on such matters as safeguards, process and design selection, and technology exports.,

IV. FUTURE DIRECTIONS

As the world increases its use and reliance on nuclear technologies for energy and other peaceful applications, there will be a need for a corresponding effort to assure that nonproliferation goals, as enunciated by the IAEA, are realized. There are many national and international programs that are aimed at providing this assurance. The PR&PP methodology is an analysis tool that can help to assess and manage the risks posed by threats to the peaceful use of nuclear technologies. Some area in which PR&PP studies could prove effective in reducing proliferation risk are indicated below.

Enabling Future Nuclear Energy Designs

As new and innovative design are developed for nuclear energy systems through GIF and INPRO, the PR&PP methodology approach will be essential to incorporating good design principles for PR&PP into new emerging and viable concepts. The work that is just beginning between the PR&PP WG and the GIF SSCs will serve as a key model for how to implement this process.

Supporting Safeguards by Design

The PR&PP methodology approach can be a useful tool in developing safeguards by design as outlined in the NGSI and in recent parallel activities by the IAEA. Results of PR&PP evaluations can serve as clear discriminators among design alternatives and could thus help to make choices that reduce proliferation risk.

Guiding Future Global Fuel Cycle Architectures

Both national and international initiatives have proposed schemes for managing fuel cycle arrangements among participating nations. These schemes typically involve assured fuel supply and management of spent fuel. Some studies have been performed[7, 12, 13] in this regard and further evaluations using the PR&PP methodology would be warranted as alternative architectures are proposed.

Integration of PR&PP with Other Performance Objectives

The use of PR&PP to guide design choice should be done with consideration to other performance objectives for the technology being evaluated. In particular, safety and economics are key drivers for determination of technology options and therefore should be incorporated into a broader scheme for informed decision making. There are ongoing and continuing efforts to integrate these drivers with PR&PP considerations.

Perspective on Extrinsic Measures

PR&PP evaluations, if suitably framed to encompass the broader context of institutional measures, may provide insights to the effectiveness state level approaches, integrated safeguards, and the additional protocol.

Export Control

The PR&PP methodology can be used to evaluate the proliferation impacts associated with particular cases of export of nuclear fuel cycle technologies, materials, and information or to address the broader issue of evaluating the effectiveness of current practices.

PR&PP as a Quality Assurance Tool

Evaluations of proliferation resistance and physical protection have been and will be performed by various parties with interest in this area. The results of these studies and the analysis steps can be checked with the PR&PP methodology to understand critical assumptions, uncertainties, and validity of results.

V. CONCLUSIONS

The GIF PR&PP evaluation methodology was initially motivated by the need to have an approach to the assessment of new nuclear energy design concepts that were envisioned within the GIF program. The methodology that has been developed now enjoys wide international consensus and has been used in applications beyond the initial purpose. It is expected that subsequent applications of the methodology will (1) lead to refinement of the approach which will streamline and focus it to address issues of interest to end-users of the results and (2) have application to a more diverse set of applications that will enhance decision making in the PR&PP arenas.

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