GIF PRPPWG Activities for GEN-IV PRPP Evaluation

Presented by
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14th GIF-IAEA Interface Tele Meeting, 8 July 2020

PRPP Working Group Objectives

- ***Facilitate introduction of PRPP features into the design process at the earliest possible stage of concept development***

→ PRPP by design

- ***Assure that PRPP results are an aid to informing decisions by policy makers in areas involving safety, economics, sustainability, and related institutional and legal issues***

"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."

PRPPWG Membership: Countries and Organizations

- *Canada*
- *China*
- *Euratom*
- *France*
- *IAEA - Observer*
- *Japan*
- *NEA - Secretariat*
- *Republic of Korea*
- *Russia*
- *South Africa*
- *UK*
- *USA*

- *Current Co-Chairs:*
  - *G.G.M. Cojazzi (EC-JRC), L. Cheng (BNL-US)*
  - *G. Renda (EC-JRC), Interim Co-Chair*
- *K. Hori (JAEA) retired*
- *UK: K. Hesket, C. Holmes, from NNL appointed*
- *Canada: B. van der Ende, from CNL appointed*
- *RoK: KIM, Bong Young (KAERI)*
- *Russia: ARTISYUK, Vladimir (ROSATOM)*
- *D. Zayani, from NEA new technical secretary PRPPWG*

30th Meeting PRPPWG
06 - 08 November 2019,
Upton, New York, USA

PRPPWG Major Accomplishments

- *The Methodology: developed through a succession of revisions – currently in Revision 6 report (Japanese and Korean translations)*
- *The "Case Study" approach: an example (sodium-cooled) fast reactor system was chosen to develop and demonstrate the methodology – resulted in major report*
- *Joint Efforts with six GIF design areas (System Steering Committees or SSCs,) - resulted in major report including white papers on the six systems -> being updated*

All three reports can be obtained at public WEB site:

https://www.gen-4.org/gif/jcms/c_9365/prpp

- *GIF Updated PRPP Bibliography, January 2020*

GIF SSCs-PRPPWG Updated Template

Section	Type of Information Requested
1. Overview of Technology	Description of the various design options in terms of their major reactor parameters, such as core configuration, fuel form and composition, operating scheme and refueling mode, fresh/spent fuel storage and shipment, safety approach and vital equipment, physical layout and segregation of components, etc.
2. Overview of Fuel Cycle(s)	High level description of the type, or types, of fuel cycles that are unique to this Gen IV system and its major design options. Information such as recycle approach, recycle technology, recycle efficiency, waste form(s)
3. PR&PP Relevant System Elements and Potential Adversary Targets	For each design option, identification and description of the relevant System Elements and their potential Adversary Targets, Safeguards and Physical Security Approaches
4. Proliferation Resistance Features	High-level, qualitative overview, developed jointly by the SSC and the PR&PP working group, to identify and discuss the features of the system reference designs that create potential benefits or issues for each of the representative proliferation threats. Ideally the section should highlight the response of the system to the concealed diversion or production of material, the use of the system in a breakout strategy, and the replication of the technology in clandestine facilities
5. Physical Protection Features	High-level, qualitative overview, developed jointly by the SSC and the PR&PP working group, to discuss those elements of the system design that create potential benefits or issues for potential subnational threats, with specific discussion on the general categories of PP threats (theft of material for nuclear explosives and radiological sabotage)
6. PR&PP Issues, Concerns and Benefits	Review of the outstanding issues related to PR&PP for the concepts and their fuel cycles, the areas of known strength in the concept, and future plans for integration and assessment of PR&PP for the concept. This section would ideally terminate with a bullet list of identified PR&PP R&D needs for the system concept

System Designs Considered in the Update

GIF System	System Options considered in update	Design Tracks considered in update	Comment
GFR	Reference Concept	2400MWt GFR Mentions ALLEGRO as a GFR demonstrator	Other GEN IV designs include: EM2 (GA) ALLEGRO (V4G4) HEN MHR (High Energy Neutron Modular Helium Reactor) (CEA-ANL and GA-AREVA)
LFR	Large System	600 MWe (ELFR, EU)	These are the three reference design configurations discussed in the GIF LFR System Research Plan
	Intermediate System	300 MWe (BREST-OD-300, Ru)	
	Small Transportable	20 MWe (SSTAR, US)	
MSR	Liquid-Fueled with Integrated Salt Processing	MSFR, MOSART, MCFR, etc.	There is a wide variety of MSR technologies, encompassing thermal/fast spectrum reactors, solid/fluid fuel, burner/breeder modes, Th/Pu fuel cycles, and onsite/offsite fissile separation.
		Dual Fluid Reactor	
	Solid Fueled with Salt Coolant	Mk1 PB-FHR, TMSR-SF1, Kairos	
	Liquid-Fueled without Integrated Salt Processing	MSDR, IMSR	

System Designs Considered in the Update

GIF System	System Options considered in update	Design Tracks considered in update	Comment
SCWR	Pressure Vessel	HPLWR (EU) (Thermal)	Most concepts are based on “familiar’ technology, such as, light-water coolant, solid fuel assemblies, and batch refuelling. Implementation of Th and Pu fuel cycles creates additional special nuclear materials of concern.
		Super FR (Japan)	
		Super LWR (Japan) (Thermal)	
		CSR1000 (China) (Thermal)	
		Mixed spectrum (China)	
		Fast core (RF)	
	Pressure Tube	Canadian SCWR (Canada) (Therm.)	
SFR	Loop Configuration	JSFR (Japan)	Expect key PRPP issues to be tied to fuel handling, TRU inventory and physical protection.
	Pool Configuration	KALIMER (RoK), ESFR (EU) BN-1200 (Russia)	
	Small Modular	AFR-100 (US)	
VHTR	Prismatic Fuel Block	Modular HTR, Framatome (ANTARES)	SC-HTGR is a follow on of the ANTARES and the GA GT-MHR development. Expect some PR&PP differences between the prismatic block and pebble bed design.
		SC-HTGR, Framatome	
		GT-MHR and GT-MHR, General Atomics	
		GT-MHR, OKBM (Russia)	
		GTHTR300C, JAEA (Japan)	
		NHDD, KAERI (RoK)	
	Pebble Bed	X-Energy Xe-100	
		HTR-PM (China)	

Cross cutting topics

- Fuel type
- Coolant, moderator
- Refueling modes
- Fuel cycle architecture
- Flexibility
- Small modular and micro design options
- Safeguards
- Safety
- Security
- Economics, and
- Cybersecurity

PR&PP and IAEA

- *IAEA observer status in GIF*
- *IAEA always represented at PRPPWG meeting, active and continuous participant since early steps*
- *PRPP & IAEA-INPRO, Info. exchange, PR Harmonization work*
- *PRPPWG meeting hosted at IAEA in 2013*
- *GIF-IAEA (Previous GIF-INPRO) Interface meetings, (last one, the 13th in March 2019)*
  - *Updated interface Matrix*
- *Support interactions with the GIF SSCs and the white paper updates*

GIF-IAEA Cooperation on PR&PP (1/2)

- ***Support the ongoing process of updating the GIF SSCs-PRPPWG white papers on the six systems, by providing input and "resources" for identifying PR and PP strengths and weaknesses and by contributing to the review process.***

- ***Address PR&PP crosscutting issues.***

- ***Support the identification of potential safeguards challenges posed by the six GIF designs.***

- ***Provide guidance to designers of NPP on "PR&PP by design", building on existing and planned activities. Extend collaboration to security area.***

GIF-IAEA Cooperation on PR&PP (2/2)

- *Revision of INPRO methodology on PR*
  - *Harmonize the characterization of PR features and the formulation of measures and metrics for comparing the robustness of nuclear systems against proliferation.*

- *Identify special PR&PP features of small modular reactors (SMR) and micro-reactors.*

- *Collaborate with the IAEA and GIF RSWG on advancing the concepts of safety, security and safeguards by design*

Back-up Slides

PR&PP Methodology Paradigm

Threats

PR
-Diversion/misuse
-Breakout
-Clandestine facility

PP
-Theft
-Sabotage

PR & PP

Intrinsic
- Physical & technical design features

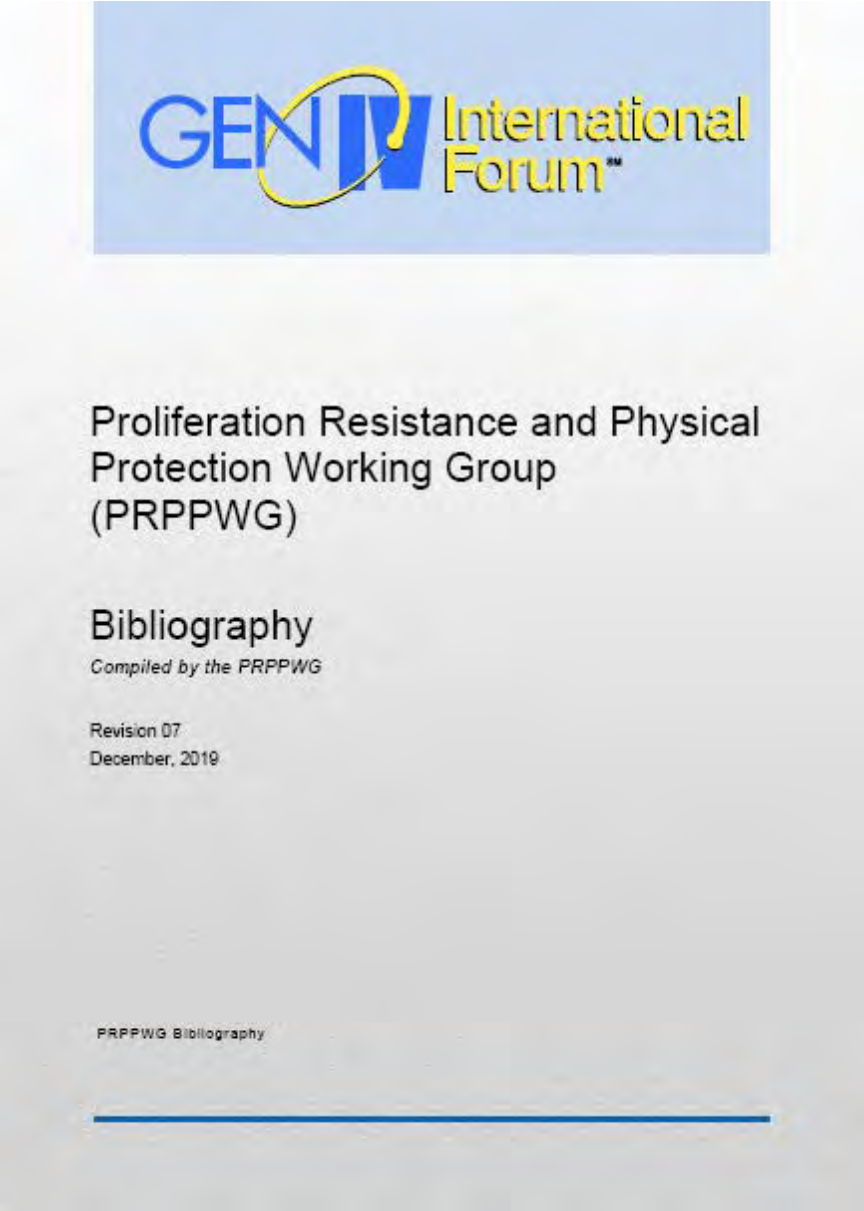
Extrinsic
- Institutional arrangements

Assessment

Measures and Metrics

The paradigm is consistent with standard approaches to safety assessment

PRPP Bibliography



PROLIFERATION RESISTANCE AND PHYSICAL PROTECTION WORKING GROUP (PRPPWG) BIBLIOGRAPHY

This bibliographic list compiles publications, including articles of scientific journals and papers presented in proceedings of conferences, symposia and workshops, related to the PR&PP Methodology developed by the GIF PRPPWG and its applications. It is intended as a source of information for interested experts and researchers within and outside the GIF community.

Sections 1 to 3 are devoted to reports, articles and papers on the PR&PP Methodology and on its applications.

Section 4 deals with articles and papers authored by PRPPWG members and/or non-members on topics related to the PR&PP Methodology.

Relevant IAEA and IAEA-INPRO documents making reference to the PR&PP Methodology are listed in Appendix A.

For the purpose of the present document "members of the PRPPWG" is defined as colleagues who are or were members or observers in the Group or contributed to its work on an ad hoc basis and, therefore, co-signed some of its outcomes.

In each section/subsection papers are presented by member country/organization in alphabetical order and, for each country/organization, chronologically.

Only references of openly available written reports, articles and papers are included; oral presentations are not considered.

Table of Contents

Some Other Recent GIF Activities

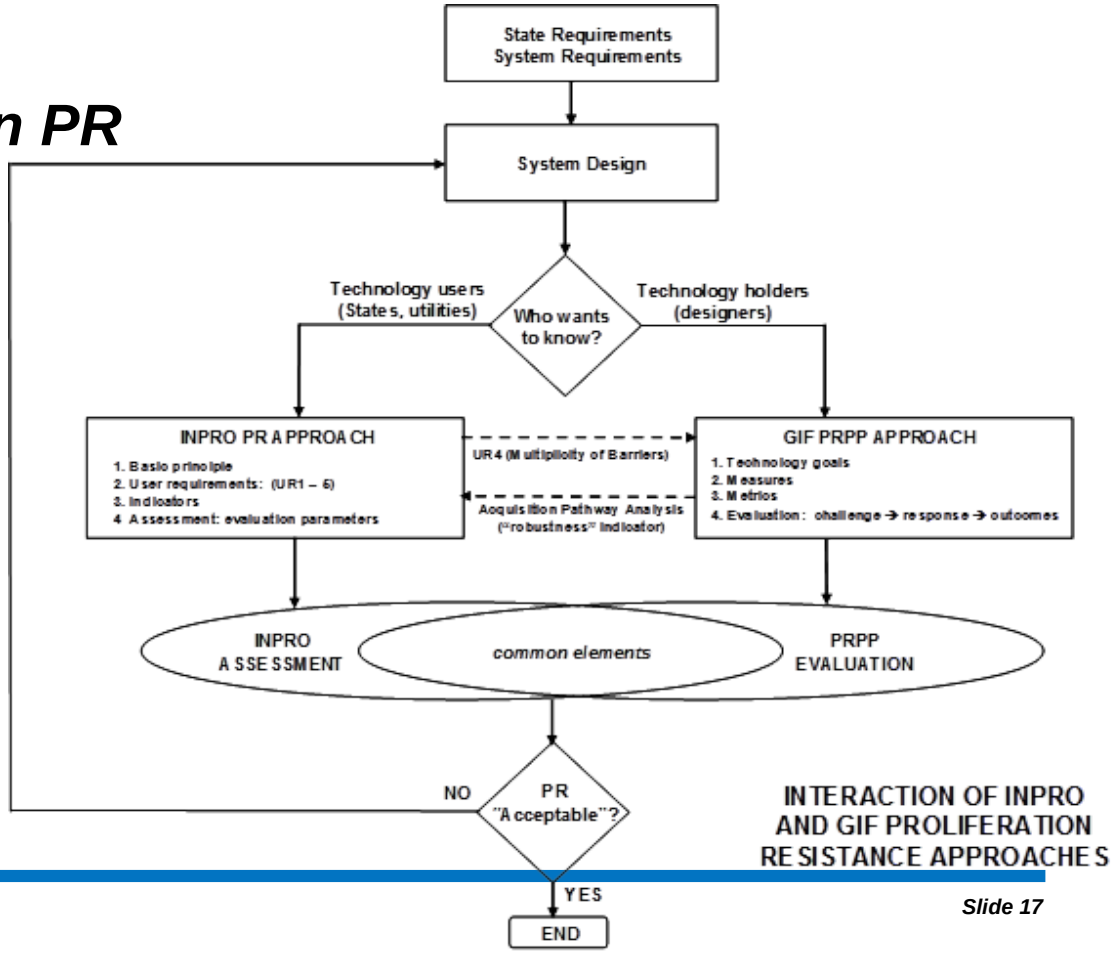
- *4th GIF Symposium, Paris, 16-18 October 2018 (Paper)*
- *EG-Meeting, Paris, 15 October 2018*
- *29th GIF PR&PP Working Group Meeting, Paris, 18-19 October 2018; joint session with the SSC/pSSC, Report.*
- *IAEA Safeguards Symposium, Vienna, 5-9 November 2018 (Paper)*
- *13th GIF-IAEA Interface meeting, Vienna, 18-19 March 2019*
- *29th GIF RSWG meeting, ANL, 11-12 April 2019*
- *EG-Meeting, Vancouver, 28-29 May 2019*
- *ESARDA Symposium 2019, Stresa, 14-16 May 2019 (Paper)*
- *ESARDA-INMM, Tokyo, 7-10 October 2019 (Contribution)*
- *EG-PG Meeting, Weihai, 17-18 October 2019*
- *30th GIF PR&PP Working Group Meeting, BNL, 6-8 November 2019; Review session.*
- *Issue of Bibliography, January 2020*

Timeline SSCs-PRPPWG Interaction

- ***2016 Preparation of the Questionnaire***
- ***2017, April, Workshop with SSCs and PRPPWG, OECD-NEA, Paris. (Internal report with replies to the questionnaire)***
- ***2017, October, PRPPWG meeting in ISPRA with session LFR & MSR (meeting report, with records of the session)***
- ***2018, October PRPPWG meeting in Paris with session with SSCs and pSSC (meeting report, with records of the session)***
- ***2019 Work in progress***
- ***2019 November Drafting and reviewing meeting, BNL, NY.***
- ***2020 Finalization***

GIF & INPRO PR harmonization efforts

- *Investigated type of users*
  - *Technology users vs. technology holders*
- *Presentation of results*
- *Possible interactions on PR*



IAEA-INPRO PR vs GIF PR&PP

- ***IAEA/INPRO methodology for nonproliferation provides "rules of good practice" for design concepts. A useful check-list → how to do things right***
- ***GIF/PRPP methodology is a systematic approach to evaluating vulnerabilities in design concepts***
  → to make sure that you did not do things wrong
- ***Methodologies both complement and supplement***
- ***IAEA/INPRO is more broadly known to IAEA community; GIF/PRPP provides a powerful analytical tool for evaluating strong and weak spots and therefore enhancing nonproliferation characteristics in a design***
- ***Together both are potentially useful in national programs***