International Atomic Energy Agency

INPRO and GIF

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INPRO-GIF Interactions

- Continuous Participation of IAEA in GIF policy and expert groups.
- GIF participation in INPRO SCMs as observer.
- Ongoing discussion by GIF and INPRO secretariat about options of general cooperation.
- Performance of comparison of both assessment. methodologies in January 2004, based on GIF peer review of INPRO Methodology.
- GIF participation in INPRO meetings on Proliferation Resistance.

Objectives of GIF and INPRO

GIF

Develop one or more nuclear energy systems:

- which are deployable by 2030;
- offer significant advances in sustainability, safety and reliability, proliferation and physical protection, economics;
- can compete in various markets;
- offer various energy applications: electricity, hydrogen, clean water, and heat.

INPRO

- to help to ensure that nuclear energy is available to contribute in fulfilling, in a sustainable manner, energy needs in the 21st century.
- to bring together all interested MS, both technology holders and users, to consider jointly actions required to achieve desired innovations in INS ……
- to create a process that involves all relevant stakeholders…..

Time horizon is 50 years into the future

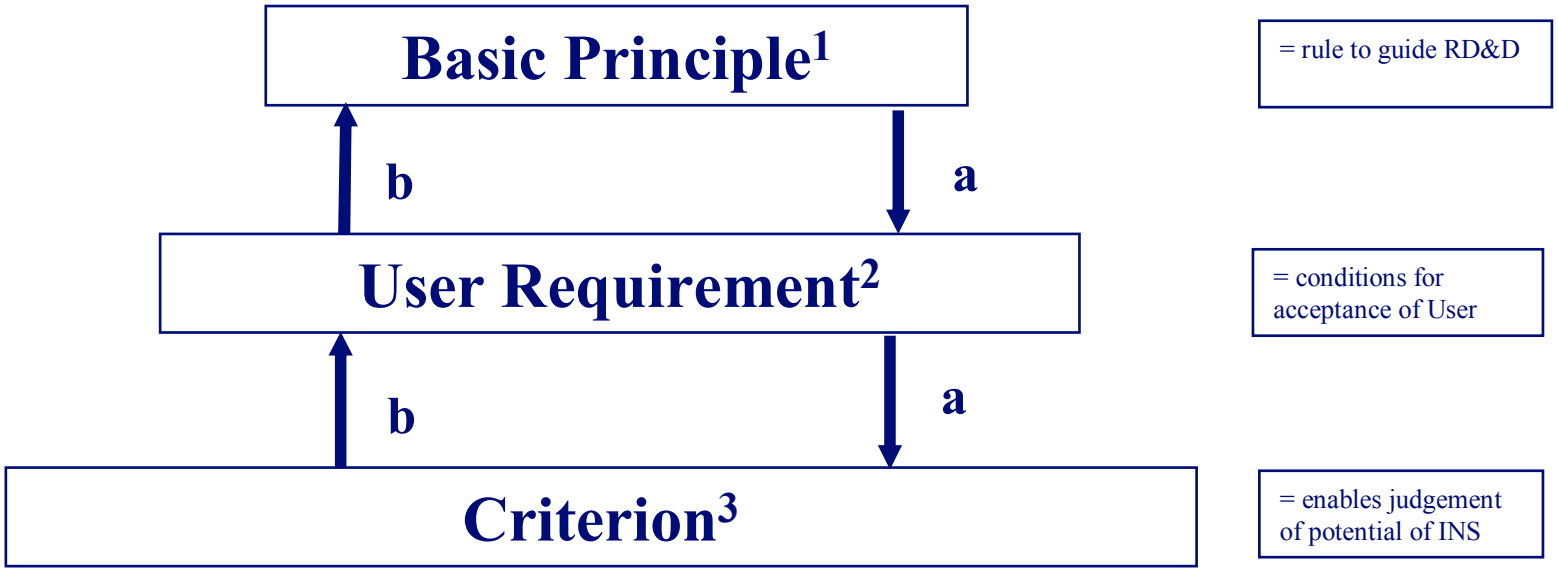
Targets of GIF and INPRO

GIF	INPRO
- Definition of innovative reactor systems and fuel to be deployed deployed after 30 years (after 2030).	- Definition of innovative nuclear energy systems INS to be within next 50 years and beyond.
- Deployment of NE in next 30 years with Generation III systems, to be done by industry + market.	- Development of such INS suitable for all MS, especially for developing countries.
- Definition how to spend government money in R&D, primarily by technology holders.	- Achievement of a sustainable development of nuclear energy local, regional and global

Comparison of the structure of INPRO and GIF

INPRO	GIF
• **Basic principle** is a statement of a general rule that provides broad guidance for the development of an innovative design (or design feature) of a Nuclear Energy System.	• **Goal statement** is intended to serve as the basis for developing criteria to assess and compare the system in a technology roadmap, to define and guide development and design of G-IV systems; and to stimulate the search for innovative nuclear energy systems.
• **User requirements** are the conditions that must be met to achieve User's acceptance of a given INS.	• **Criterion** a sampling of performance indicator that reflect the breadth of the G-IV goals.
• **Criterion (one or more)** is to determine whether and how well a given UR is being met. A criterion includes an Indicator (ID) and an Acceptance Limit (AL). *Indicators may be based on a single parameter, on an aggregate variable, or a status statement.* *An Acceptance Limit is a target, either qualitative or quantitative, against which the value of an Indicator can be compared leading to a judgement of acceptability (pass/fail, good/bad, better/poorer).*	• **Metric** is a specific measure of each performance indicator (criteria) *In the potential evaluation step, the criteria metrics are 100% qualitative (estimate relative to reference)* *In the final screening step, the criteria metrics are qualitative and quantitative (over half are quantitative)*

Definition of Selected INPRO Terms



a = Derivation of hierarchy
b = Fulfilment of hierarchy

1 ~ Goal in GIF
2 ~ Criteria in GIF
3 ~ Metrics in GIF

INPRO Hierarchy of Demands on Innovative Nuclear Energy Systems (INS)

Assessment methodology in GIF and INPRO

GIF

- Used for screening of reactor and fuel concepts to select superior designs compared to existing LWR's. system.
- To be used for R&D control

- Methodology consists of
  - 8 goals
  - 15 criteria
  - 24 metrics

INPRO

- To be used for finding suitable INS for all interested MS.
- Holistic view on NE

- Assure sustainability of INS

- Methodology consists of
  - 14 basic principles
  - 38 user requirements
    - about 100 criteria

Comparison of the Areas Considered

INPRO	GIF
• Economics • Sustainability and Environment • Safety • Waste Management • Proliferation Resistance • Cross cutting issues[2]	• Economics • Sustainability[1] • Safety and Reliability • Proliferation resistance and physical protection

1- GIF considers impact on the environment and waste management under sustainability.

[2] There is no equivalent of cross cutting issues as used in INPRO for GIF. G-IV roadmap, however, present crosscutting R&D recommendations for each GIF area which is fundamentally different from what is considered as cross cutting issues by INPRO.

Judgment levels of GIF and INPRO

	Level-1	Level-2	Level-3	Level-4	Level-5	Level-6	Level-7
GIF	**MWTR**	**WTR**	**SWTR**	**STR**	**SBTR**	**BTR**	**MBTR**
INPRO	**NP**	**NP**	**NP**		**P**	**HP**	**VHP**

(no potential (NP), Potential (P), High Potential (HP) and Very High Potential (VHP)) whereas GIF employs a variable level approach with maximum seven levels (Much Worse Than Reference (MWTR), Worse Than Reference (WTR), Slightly Worse Than Reference (SWTR), Similar To Reference (STR), Slightly Better Than Reference (SBTR), Better Than Reference (BTR), Much Better Than Reference (MBTR).

Status of GIF and INPRO

GIF

- 6 concepts (reactor + fuel) chosen.
- R&D programs to be started.
- Multinational cooperation programs for R&D to be established.

INPRO

- Methodology for assessment defined (Phase 1A).
- Methodology tested and validated (Phase 1B, 1st part).
- Methodology to be applied to define suitable INS for MS and necessary R&D (Phase 1B, 2nd part).
- Multinational R&D programs to be established (Phase 2).

INPRO Types of Indicators

- Real **Indicator: experimentally verified or calculated value reflecting a property of INS,e.g. overnight construction cost**
- Integer **Indicator: number in a list,e.g. number of barriers**
- Logical **Indicator: yes or no, e.g. is level of knowledge adequate?**

GIF-INPRO

- GIF is already in the phase of initiating R&D, while INPRO has only just completed formulation of its user requirements;
- GIF mainly addresses the demands of a few industrially-developed countries, while INPRO offers a more in-depth consideration of nuclear power in general, taking into account country and region specifics;
- GIF limits its consideration to separate nuclear energy systems with reactors of different types and accompanying fuel cycles.

- **INPRO is expected to involve a broader spectrum of technology proposals for innovative reactors and nuclear fuel cycles, which would meet the demands of nearly all countries – and not just nuclear stakeholders.**
- **INPRO also seeks to address issues beyond technological requirements, particularly the possible advantages of international cooperation in establishing the necessary infrastructure for individual countries, as well as innovations in legal and institutional structures.**
- **INPRO is ready to consider the needs of developing countries in this regard.**
- **INPRO considers that the combinations of such systems should be tailored to different scenarios of nuclear power development at national, regional, and global levels.**

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II. Areas of cooperation

- Exchange of information on results achieved in both projects
  - INPRO examples
    - Needs of developing countries
    - Computer tools for modelling of INS scenarios
    - Harmonization of codes, standards and licensing
    - Indicators for sustainable development
    - Multinational Fuel Cycle Centers
    - Impact of Globalization on INS development and deployment
  - GIF
    - Non proprietory information on GIF reactor and fuel cycle concepts
    - Others?

III. Options for implementation

- Exchange of publications
- Joint participation in Consultants and Experts Meetings
- Assessment of GIF concepts via INPRO methodology

Conclusions

- The maximum possible resources and intellect should be dedicated to the development and establishment of an integrated nuclear power structure capable of ensuring sustainable development and hence sustainability for the entire economic system.
- Based on knowledge of the potential of nuclear power, we should predict and at some level stimulate new demand for nuclear technologies; in meeting those demands we will, in turn, demonstrate the advantages and desirability of nuclear power.

Conclusions

- **The aims and tasks of INPRO and GIF and other international projects are mutually complementary, and all in all address the major short- and long-term issues related to nuclear power development.**
- **Since it is not possible for a single country on its own to solve the problems associated with the full-scale development of innovative nuclear technologies, for the project's goals to be attained it is essential that efforts under INPRO, GIF and other international projects be united and that joint funds be created to address the issues of nuclear power development.**

Conclusions

- We need to strive towards a common methodological basis for INPRO, GIF and other international projects, and develop joint scientific and technical programmes:
- for the selection and development of nuclear fuel cycle technologies;
  - for the development of designs and the establishment of a comprehensive R&D programme for modelling nuclear power facilities of various classes (power series), various types (thermal, synthetic fuel, etc.);
  - for spent fuel and radioactive waste storage and disposal issues.

Conclusions

- **There is a need to find ways of, and start, collaboration between the developed and the developing countries for the joint resolution of problems associated with the full-scale development of innovative nuclear power, including:**

  - **training personnel and building confidence between countries;**
  - **increasing countries' participation in the introduction (expansion) of nuclear power; reducing imports, that is reducing for countries the cost of developing and/or expanding nuclear power;**
  - **greater standardization of equipment, designs and construction**