Status and Prospective of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)

Masanao Moriwaki, Atam Rao, Akira Omoto, and Yuri Sokolov

International Atomic Energy Agency (IAEA), Wagramer Strasse 5, P.O. Box 100, A-1400 Vienna, Austria

Abstract

The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) is an international forum for discussion of experts and policy makers on all aspects of nuclear energy planning as well as on the development and deployment of innovative nuclear energy systems (INS), for which the IAEA provides the secretariat function. INPRO brings together technology holders, users and potential users to consider jointly the international and national actions required for achieving desired innovations in nuclear reactors and fuel cycles, while it pays particular attention to the needs of developing countries. Currently INPRO Members count 27 including five countries, which are not yet operating nuclear reactors. During its Phase-1 activity, INPRO had focused on its methodology development, which ensures that INS can contribute to sustainable energy supply in the 21st century. In the current phase, Phase-2, which had newly started in July 2006, INPRO activities are oriented by three directions: 1) application of INPRO methodology for INS assessment and continuous improvement of methodology, 2) institutional/infrastructure activities and 3) collaborative projects among interested INPRO Members.

Keywords: INPRO; Innovative nuclear energy system; Sustainability; Methodology

1. Introduction

1.1 Establishment

The 21st century promises the most competitive, globalized markets in human history, the most rapid pace of technological change ever, and the greatest expansion of energy use, particularly in developing countries. For a technology to make a truly substantial contribution to energy supplies, innovation is essential. It will be the defining feature of a successful nuclear industry and a critical feature of international cooperation in support of that industry, cooperation that ranges from joint scientific and technological initiatives, to safety standards and guidelines, and to security and safeguard activities.

The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) was initiated in the year 2001, based on a resolution of the IAEA General Conference in 2000 (GC(44)/RES/21). Thereafter, INPRO activities have been continuously endorsed by resolutions of the IAEA General Conference and corresponding United Nations General Assembly.

INPRO is characterized by a broad international effort to facilitate the assessment and development of innovative nuclear reactor and fuel cycle technology, recognizing that:

- A sustainable energy supply for humanity in the 21st century will require the large-scale deployment of nuclear energy as well as other energy sources;
- Nuclear power is a technology that offers practically unlimited energy resources whose deployment can reduce environmental pollution, including greenhouse gas emissions, and the existing volumes of waste needing management.

INPRO provides an open international forum for studying the nuclear power option, and associated requirements and its potential application in IAEA Member States. INPRO helps to make available adequate competence to the development and deployment of Innovative Nuclear Energy Systems (INSs) and to assist Member States in the coordination of related collaborative projects.

1.2 Objectives, activities and schedule

The following two objectives and four missions are defined for INPRO:

(Objectives)

- To help ensure that nuclear energy is available to contribute, in a sustainable manner, to the energy needs in the 21st century.
- To bring together technology holders and users so that they can consider jointly the international and national actions required for achieving desired innovations in nuclear reactors and fuel cycles.

(Missions)

- To provide a forum for discussion of experts and policy makers from industrialized and developing countries on all aspects of nuclear energy planning as well as on the development and deployment of innovative nuclear energy systems (INS) in the 21st century;
- To develop the methodology to assess INS on a global, regional and national basis and to establish it as an IAEA recommendation;
- To facilitate coordination and cooperation among Member States for planning of INS development and deployment;
- To pay particular attention to the needs of developing countries interested in INS.

Figure 1 shows the overall schedule of INPRO. Phase-1, which started in 2001 and finished in June of 2006, was mainly dedicated to development of a methodology to assess INS, where INPRO had defined requirements organized in a hierarchy of Basic Principles, User Requirements and Criteria (consisting of an indicator and an acceptance limit) to be met by INS in 7 areas, namely: economics, safety, waste management, environment, proliferation resistance, physical protection, and infrastructure. In Phase-1A [1][2], the basis of the methodology was established and compiled as IAEA TECDOC-1362 [3] in June 2003. In subsequent Phase-1B (first part) [4], INPRO Members conducted case studies to verify the basis of the methodology and their results were used to complete the methodology and produce TECDOC-1434 [5] in the end of 2004. In Phase-1B (second part) [6], the draft manuals had been developed, for each INPRO area, to provide guidance for performing an assessment of whether an INS meets the INPRO requirements in a given area. In parallel, studies by INPRO Members to assess their own INS or its components with INPRO methodology were initiated and many of them still continue at present.

In Phase-2 [7], which started in July 2006, activities are characterised by three main directions: 1) Application of INPRO methodology for INS assessment and continuous improvement of methodology, 2) Institutional/infrastructure activities and 3) Collaborative projects among interested INPRO Members. Since the latter two need further international cooperation, Phase-2 is also called international cooperation phase.

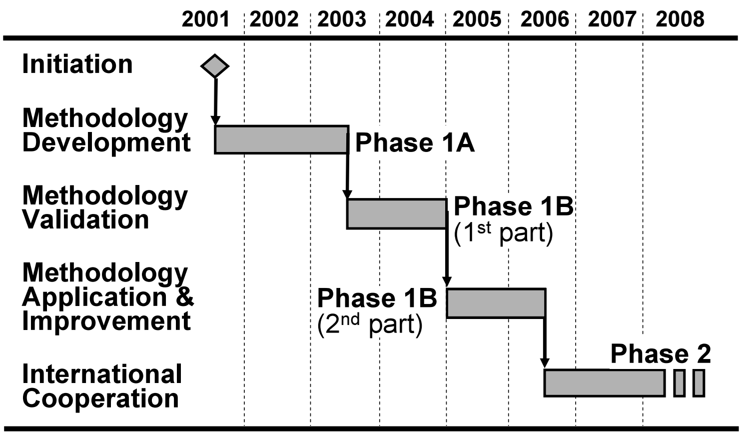

Fig. 1 INPRO schedule

1.3 Project formation and members

INPRO is a forum of Members and its decision making function is provided by the INPRO Steering Committee (SC), which comprises representatives from INPRO Members and observers. The SC meets as appropriate (1 or 2 times a year) to provide overall guidance, advice on planning and methods of work and review the results achieved. Figure 2 shows the SC and internal INPRO project formation.

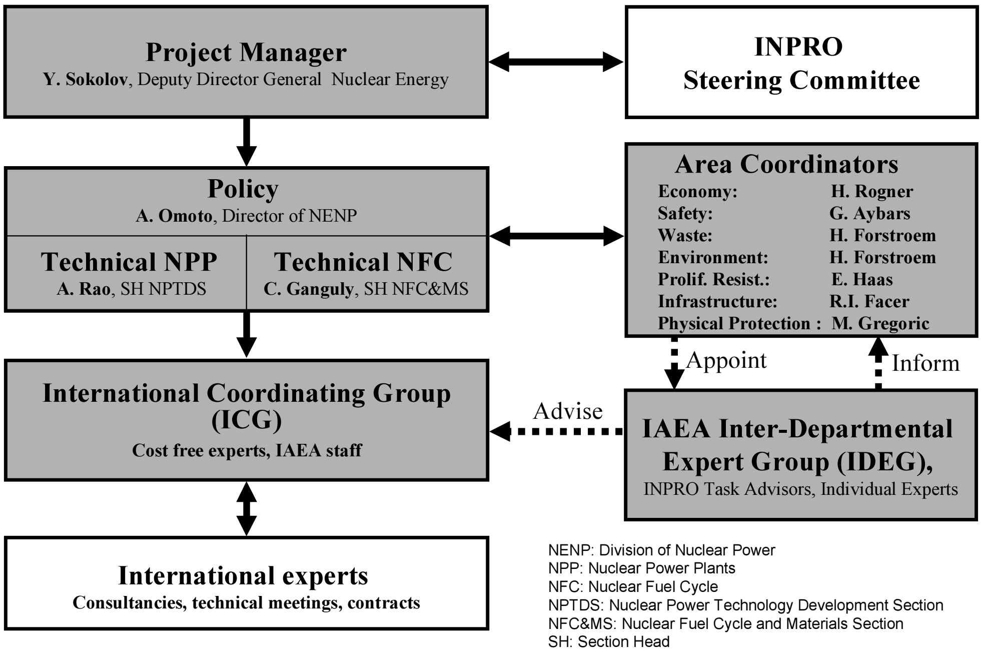

Fig 2 INPRO project formation

The project manager is Mr. Sokolov, who is the Head of Nuclear Energy Department and a Deputy Director General of the IAEA. He reports to the INPRO SC and supervises three coordinators for policy coordination (Mr. Omoto, Director of the Nuclear Power Division), and technical coordination (Mr. Rao, Section Head of the Nuclear Technology Development Section for issues regarding nuclear power plants, and Mr. Ganguly, Section Head of the Nuclear Fuel Cycle and Materials Section, for issues regarding fuel cycle facilities). Under the guidance of the coordinators the INPRO activities are implemented by the International Coordinating Group (ICG). The ICG consists of cost-free experts (CFEs) from INPRO Members and one to two IAEA regular staff members. At present, there are 3 CFEs from Russia, 1 from Spain and 1 from the Republic of Korea, and there are additional 3 CFEs, who are partially engaged as members of ICG, from Canada, France and USA, respectively. The total number of CFEs in ICG that have been nominated by INPRO Members to date reaches 30, which indicates the strong international interest. ICG members, who share their responsibilities to implement various tasks, are located in the Nuclear Power Technology Development Section, but they need cooperation with other sections, divisions and departments of the IAEA to cover a wide variety of issues. For this purpose, internal experts with expertise from outside the Section form the Inter-Departmental Expert Group (IDEG) and support the ICG. IDEG members are appointed by their respective Area Coordinators from the higher level management to whom they report to receive advice for coordination in the seven INPRO areas.

As of April 2007, there are 27 INPRO Members as following: Argentina, Armenia, Belarus, Brazil, Bulgaria, Canada, Chile, China, Czech Republic, France, Germany, India, Indonesia, Japan, Republic of Korea, Morocco, The Netherlands, Pakistan, Russia, Slovakia, South Africa, Spain, Switzerland, Turkey, Ukraine, USA and the EC. As indicated in Fig. 3, physical location of Members are scattered over the world and their number has been growing steadily. Recently Kazakhstan, Algeria and Belgium expressed their intentions to join INPRO.

Currently the financial resources of the project mainly depend on extra-budgetary contributions from Members, which makes thorough project planning and implementation rather difficult, and it is, therefore, being considered to shift activities within the first two directions to the regular budget in order to stabilize the project budget.

Fig. 3 INPRO Members (as of April 2007)

1.4 Cooperation with other international programs

INPRO seeks continued cooperation with other national and international initiatives, such as the Generation-IV International Forum (GIF). GIF is an international project to develop Generation–IV nuclear reactors and fuel cycle systems. It has already selected 6 reactor types and has been performing R&D to demonstrate them. While GIF members are technology holder countries, INPRO comprises many technology user countries including potential user countries which do not have commercial nuclear power plants yet such as Turkey, Chile and Morocco. On top of the difference on their memberships, there are also differences in the areas of activities (GIF: R&D concentrated, INPRO: 3 directions) and viewpoints (GIF: developer's viewpoints, INPRO: emphasis on user's viewpoints).

The IAEA/INPRO has cooperated with GIF by sending experts to its working groups (Economic Modelling WG, Proliferation Resistance and Physical Protection WG, Risk and Safety WG) as well as to Policy Group Meetings. Interface meetings between both secretariats were held in 2004 and 2005, which discussed areas of collaboration and confirmed the complementary nature of INPRO and GIF.

The importance of the development of innovative nuclear systems and the complementary nature of INPRO and GIF in this regard was also confirmed in a G-8 Summit Statement on GLOBAL ENERGY SECURITY [8], adopted by the Heads of State and Government of the G8 member countries in St. Petersburg, July 16, 2006 as follows;

"The development of innovative nuclear power systems is considered an important element for efficient and safe nuclear energy development. In this respect, we acknowledge the efforts made in the complementary frameworks of the INPRO project and the Generation IV International Forum."

2. Development of INPRO Methodology

2.1 Usage of methodology

The INPRO methodology seeks to ensure that INS can contribute to the energy supply needs in the 21st century according to the general objective of sustainable development, which means to take into account its four dimensions, namely, social, economic, environmental and institutional. Seven areas were derived from four dimensions to ensure the methodology can cover all necessary requirements that INS should fulfil. These areas are economics [9], safety [10], environment [11], waste management [12], proliferation resistance, physical protection, and infrastructure.

There are three usages for users to apply INPRO methodology for their INS assessment;

1) Screen INS to evaluate their compatibility with the criteria of the INPRO methodology;
2) Compare different INS or components thereof to find a preferred or optimum INS consistent with the needs of a given IAEA Member State;
3) Identify the research and development needed to improve the performance of existing INS components or to develop new components.

By using the methodology, users can check adequacy of their system, to be developed by them or to be introduced externally, and/or their national or regional scenario of INS development and deployment, by objective point of view.

2.2 Scope of INS

INS encompasses all systems that will position nuclear energy to make a major contribution to global energy supply in the 21st century. In this context, future systems may include evolutionary as well as innovative designs of nuclear facilities. An evolutionary design is an advanced design that achieves improvements over existing designs through small to moderate modifications, with a strong emphasis on maintaining the envelope of proven designs to minimize risks associated with the new designs. An innovative design is an advanced design, which incorporates radical conceptual changes in design approaches or system configuration in comparison with existing practice.

INS should comprise the complete spectrum of nuclear facilities and associated institutional measures. Nuclear facilities include facilities for: mining and milling, processing and enrichment of uranium and/or thorium, manufacturing of nuclear fuel, production (of electricity or other energy- related products, e.g., steam, hydrogen, desalination), reprocessing of nuclear fuel (if a closed nuclear fuel cycle is used), and facilities for related materials management activities, including storage, transportation and waste management. Within INPRO, all types of reactors (e.g., cooled by light and heavy water, gas, liquid metal and molten salt, of different sizes of thermal power and use, such as for production of electricity as well as for non-electric application such as use of its heat for chemical process, and for partitioning and transmutation of actinides and fission products) and associated fuel cycles (e.g. U, U–Pu, Th, U–Pu–Th cycle) may be considered. All phases in the life cycle of such facilities are included, such as site acquisition, design, construction, equipment manufacture and installation, commissioning, operation, decommissioning and site release/closure. Institutional measures consist of agreements, treaties, national and international legal frameworks and conventions (such as the NPT, the International Nuclear Safety Convention, IAEA Safeguards Agreements) as part of the national and international infrastructure needed to deploy and operate a nuclear program.

Finally, INPRO covers INS expected to come into service in the next 50 years and beyond.

As defined above the scope of INS is broad. By applying the methodology with all 7 areas to this comprehensive definition of INS, users can ensure that their INS can contribute to sustainable development of 21st century. This “holistic approach” is a distinctive feature of INPRO methodology.

2.3 Main characteristics of methodology

The methodology consists of a set of Basic Principles, User Requirements and Criteria, which is structured in a hierarchical order as shown in Fig. 4. The highest level in the structure is a Basic Principle (BP), which is a statement of a general rule that provides broad guidance for the development of an INS (or design feature). All basic principles shall be taken into account in all areas considered within INPRO. An example of a basic principle, taken from the INPRO area of safety, is that *an INS shall incorporate enhanced defence-in-depth as a part of its fundamental safety approach and ensure that the levels of protection in defence-in-depth shall be more independent from each other than in existing installations*.

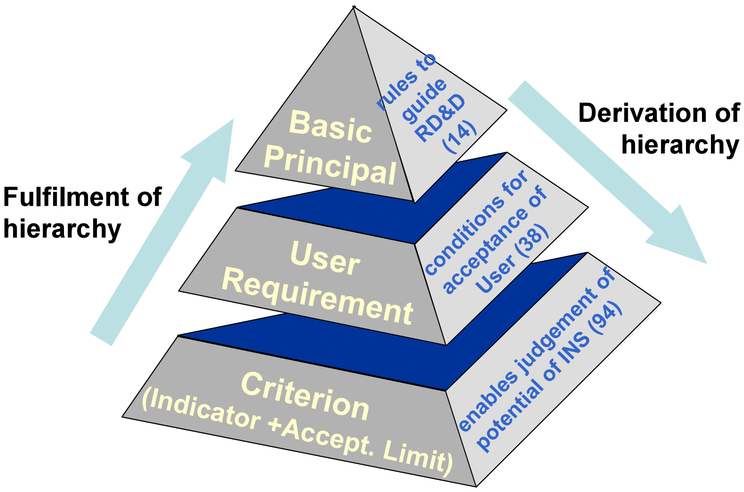

Fig. 4 INPRO methodology structure

The second level in the hierarchy is called a User Requirement (UR). URs are the conditions that must be met to achieve users' acceptance of a given Innovative Nuclear Energy System. A user is an entity that has a stake or interest in potential applications of nuclear technologies. Users, in the context of INPRO, encompass a broad range of groups. The URs set out measures to be taken to ensure fulfilment of the basic principle(s) to which they relate. An example for a UR in the area of nuclear safety is the functional requirement that *a major release of radioactivity from an installation of an INS should be prevented for all practical purposes so that INS installations would not need relocation or evacuation measures outside the plant site, apart from those generic emergency measures developed for any industrial facility used for similar purpose*.

Finally, a Criterion (CR) (or more than one) is required to determine whether and how well a given user requirement is being met. A criterion consists of an Indicator (IN) and an Acceptance Limit (AL). Indicators may be based on a single parameter, on an aggregate variable, or on a status statement. One important aspect of the INPRO assessment method is the mathematical classification of the indicators. Three types of indicators are distinguished within the INPRO method:

1. **Real Indicator:** An experimentally verified or calculated value of one parameter varying continuously within the limits of a range.
   Examples: The numerical economic, safety and environmental parameters, representing the bulk of quantitative information about the system.
2. **Integer Indicator:** An integer number assigned to each of the components of a ranked list of items.
   Examples: The number of safety barriers maintained after severe accident.
3. **Logical Indicator:** A variable with only two possible values, 0 and 1, which in the assessment procedure is interpreted as "yes" and "no" (acceptance or rejection).

Logical indicators are usually associated with some necessary features of the INS and are only used for screening, not as metrics. Example: A question in a user requirement such as “Is the safety concept defined?”

An Acceptance Limit (AL) 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).

As Fig. 4 shows, while INPRO demands are derived from top to bottom (BP – UR – CR) in the structure, fulfilment of such demands are confirmed from bottom to top (CR – UR – BP). All the BP, UR and AL are fully described in the IAEA TECDOC 1434 [5] and coming INPRO manual (see section 2.5).

2.4 Assessment studies of INS by INPRO Members

Several assessments of INSs on a national or international basis with INPRO methodology are currently being performed by INPRO Members:

- Joint assessment based on a closed fuel cycle with fast reactors (Canada, China, France, India, Japan, Republic of Korea, Russian Federation, and Ukraine);
- Assessment of hydrogen generating INS in national energy mix (India);
- Assessment on the transition from the current NPP fleet towards Generation IV fast neutron systems (France) [13];
- Assessment of additional nuclear generation capacity in the country for the period 2010-2025 for the evaluation of NFC strategies (Argentina);
- Assessment of INS for countries with a small electricity grid (Armenia);
- Assessment on complete DUPIC fuel cycle in the area of proliferation resistance (Republic of Korea)(finished already);
- Two independent assessments on IRIS and FBNR (Brazil);
- Assessment of advanced HTGR (China);
- Assessment of national INS (Ukraine); and
- Assessment of INS to meet energy demand during periods of raw materials insufficiency (Czech Republic, Bulgaria, Poland, Russian Federation, Slovak Republic).

The assessments performed are expected to contribute to identifying the needs and platforms for collaborative projects on an international scale and also to provide valuable feedback for further improvement of INPRO methodology.

2.5 Methodology manual and workshop

Although TECDOC-1434 describes the overall structure of INPRO methodology, the main explanations are made on the BP and UR levels. While assessors have to understand these upper level concepts, actual assessments have to be performed on the CR level, and TECDOC-1434 may not be enough in assessor’s points of view.

The manual to apply INPRO methodology is created to supplement this characteristic, in particular to pursue following purposes:

- To show practical procedures to evaluate INs and ALs;
- To show calculation procedures including recommendation of codes in cases of real indicators;
- To show lists of evaluation parameters to arrive final decision in cases of logical indicators;
- To show examples of evaluation as much as possible, and
- To provide guidance of other IAEA activities, documents, services and codes.

INPRO methodology focus on “assessment” by technology users rather than “analysis” by technology holders, and thus the manual is also described based on this view point. Namely, the manual naturally expects that inputs from technology holder's analysis are available before the assessments by assessors. For example, in the area of economics, the first criterion is that the cost of nuclear energy C_n should be less than the cost of energy from alternative source C_a. These C_n and C_a represent electricity generation costs, and assessors needs several inputs to calculate these costs, such as capital costs, construction periods, discount rates, fuel costs and so on. In the manual, capital costs and construction periods are defined as inputs from technology holders, thus processes to calculate these costs are out of scope in the manual. In summary, one of the important roles of the manual is to distinguish between inputs from technology holders and assessments by assessors, and to guide technology users what and how to assess in a practical manner.

The manual is a set of documents consisting of 9 different volumes: overview, economics, infrastructure, waste management, proliferation resistance, physical security, environment, safety on nuclear reactors and safety on nuclear fuel cycle facilities. Production of the manual was initiated in the beginning of 2005 and every volume has been prepared in parallel. The manual has been distributed to INPRO Members as a draft and will be published as a TECDOC in the middle of 2007.

Workshops are also provided to support assessors to use INPRO methodology for their INS assessments. A workshop in June 2006 attracted 39 participants from 32 countries plus European Commission, where lectures were provided by 6 external and 7 internal experts. The workshop allowed dissemination of INPRO achievements to IAEA Member States, especially to countries which are pursuing the option to introduce a nuclear system in the near future.

2.6 Effort needed for INS assessment with INPRO methodology

An assessor will only need to work with the manual for those areas, for which he wants to assess an INS. The time needed for an assessment for one area will strongly depend on the successful data gathering. It is expected that for each area of INPRO one expert (i.e. a person knowledgeable in that INPRO area) would need about 8 weeks to perform a specific INPRO assessment, assuming he had made himself familiar with the INPRO methodology and received all the needed input before starting his assessment. Familiarization with the INPRO methodology in a specific area should take not significantly more than about two weeks. Collecting of the input could be done iteratively during the assessment work, but might cause significant delay of the overall schedule. Thus, a complete INPRO assessment of an INS should require a team of about eight people, each of whom would work about 10 weeks in his subject area, plus a project manager to bring together a comprehensive report (~ 2 – 4 weeks). Thus, optimistically, the accumulated effort by the team of experts should be about 80 persons weeks plus the time needed for the project manager.

3. Collaborative Projects

3.1 Purpose

Collaborative projects (CPs) are new activities which characterize INPRO Phase 2. INPRO CPs provide a forum for INPRO Members to conduct collaborative activities regarding the development and deployment of INS so that international collaboration may enable sharing of resources, reduce required resources and create synergy by working together.

3.2 Project scheme

As Fig. 5 shows, INPRO Members are expected to identify the common needs for collaborative projects through national or joint INPRO assessment of INS, based on other INPRO activities, or from their national priorities for development activities, and then to propose them to INPRO in order to discuss possible options for their implementation and to find partners. INPRO CPs can provide following three options for INPRO Members to perform their projects;

- Coordinated Research Projects (CRP)
- Technical Cooperation Program (TCP)
- Joint Initiative (JI)

CRP and TCP are well established scheme in the IAEA, the latter focuses on the transfer of well-tried and tested technologies which nevertheless often requires significant adaptive research in the process of adoption by “end-users”, while the former provides opportunities for scientists and institutions in IAEA Member States to conduct the more “upstream” types of research.[14][15] JI is an INPRO unique framework to provide CPs more flexibility regarding the number of participants, budget scale and timeframe to conduct CPs. JI shall, however, follow the IAEA’s statutory requirement (Article III A 1 and 3 [16]) and should not duplicate other IAEA activities and should take advantage of synergies with other international activities on innovative nuclear technology development.

The generic expectation of the INPRO Members for projects under the auspice of IAEA/INPRO may be collection of data, code benchmarking and validation, scenario or vision for nuclear power development, and method development, but their proposals may not be limited to those, depending on the wishes of the INPRO Members and the availability resources on the IAEA as well as INPRO Members.

Figure 6 shows the overall flow of CPs and roles of INPRO Members, the Steering Committee and IAEA/INPRO secretariats. Main players are INPRO Members who propose, plan, implement and report their CPs. The Steering Committee provide advices and concurrences on CPs. The IAEA/INPRO secretariat’s function is mainly support and coordination of CPs.

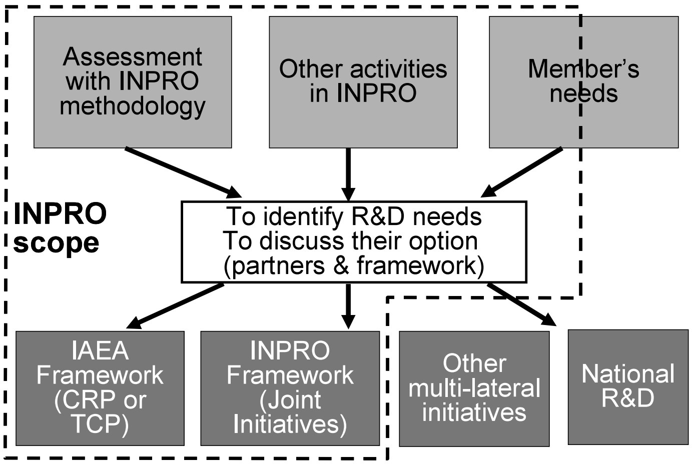

Fig. 5 Scope of INPRO collaborative projects

3.3 Proposals from INPRO Members

In the 10th INPRO Steering Committee meeting in December 2006, seven INPRO Members proposed 20 different CP proposals. Many of them were related to software issues as expected such as analysis, benchmarking, infrastructure/institutional issues, and development of methodologies, although a small number of the proposals pointed to hardware issues such as experiments and system design. As technical disciplines, there were proposals in scenario/vision development, high temperature reactors, high temperature gas cooled reactors, water cooled reactors, liquid metal fast breeder reactors, reactor safety and reliability, proliferation resistance, environment, and fuel cycle issues. In the meeting, more than two INPRO Members showed their interests in each of the proposals excepts few proposals, which indicates that these proposals have a possibility to be implemented as INPRO CPs. Once they are well-defined by discussion with potential partners, they will be discussed in the next

Steering Committee meeting in July 2007 and some of them are expected to receive its concurrence for implementation.

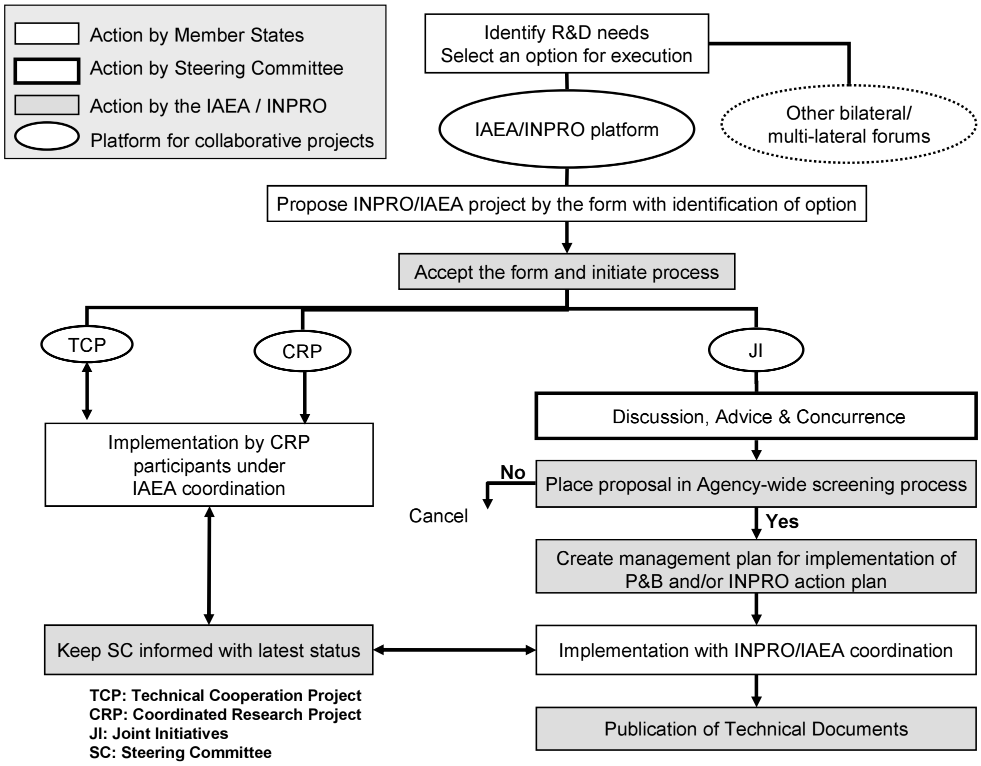

Fig. 6 Process flow of INPRO collaborative projects

4. Common User Criteria

4.1 Objective

The IAEA General Conference (GC) in 2006 emphasized the need to develop Common User Criteria (CUC) by the IAEA, including infrastructure development requirements, domestic legal and regulatory frameworks, provisions for removal and disposal of the spent fuel, and flexible financing arrangements, which are needed by potential users of new nuclear power plants in developing countries. Responding to the this GC Resolution, INPRO started a new activity called "Common User Criteria and Actions for Development and Deployment of Nuclear Power Plants for Developing Countries". The main objective of this activity is to facilitate understanding between technology users and holders by conveying users' needs to technology holders and subsequently to consider necessary actions together to fulfil the needs.

4.2 Common User Criteria

CUC will cover general technical and economical characteristics of nuclear power plants and associated support and service factors provided by system suppliers and/or supplier countries including fuel cycle options. The desired characteristics would represent the needs and requirements of many user countries and intended as guidance for developers of advanced nuclear power plants. CUC will cover both shorter and longer timeframes (until 2015 and 2050, respectively) to consider both short-term actions and long-term technical developments. Countries considered in CUC are about 50 countries, most of which are categorized as "Developing Economies" by the World Bank Group with few exceptions, that currently have no or limited nuclear capacity but have expressed an interest in deployment of NPP.

4.3 Activity plan

There are two stages considered in this activity. In the first stage (2007), CUC is created by discussion with potential users in developing countries. The second stage (2008), depending on wishes of the IAEA Member States, would define necessary actions to be taken by technology holders and users jointly to pave the way for the development and deployment of different options (including fuel cycles).

For the stage 1, the first few steps involve visits to several potential user countries, which represent a variety of typical characteristics of potential user countries, for detailed discussions with various stakeholders in the countries and to develop a draft of CUC. The draft CUC would then be reviewed with all developing countries potentially interested in new nuclear plants to refine and finalize the CUC by the end of 2007.

The stage 2 would consider identification of options and designs, including those with different power levels, coolant and design characteristic and institutional and infrastructure arrangement that would assist deployment of such systems and help achieve the sustainable use of nuclear energy.

5. Conclusion

INPRO entered a new phase, Phase-II, which activities are characterised by following three directions: 1) application of INPRO methodology for INS assessment and continuous improvement of methodology, 2) institutional/infrastructure activities and 3) collaborative projects among interested INPRO Members.

In the first direction, the methodology manual composed by 9 volumes is developed to guide assessors for the assessment of their innovative nuclear energy systems. Eleven assessment studies with the methodology by INPRO Members are going on and are expected to provide feedback to a potential further improvement of the methodology.

In the second direction, common user criteria and actions will be established to improve understanding between technology users and holders by conveying users' needs to technology holders and subsequently to consider necessary actions together to fulfil the needs.

In the third direction, INPRO collaborative projects provide a forum for INPRO Members to conduct collaborative activities regarding the development and deployment of INS. Twenty collaborative proposals have been proposed already, and will be further scrutinized for their implementation.

INPRO will continue to pursue its objectives and missions through activities in these three directions.

Acknowledgement

This paper summarises various INPRO activities which have been led and performed by a team effort. Many of the team members are not listed as the authors but are acknowledged here: Yuri Busurin, Frank Depisch, Mikhail Khorochev, Juergen Kupitz, Franck Lignini, Jerry Phillips, Rayman Sollychin, Vladimir Usanov, Palmiro Villalibre and Hean-Joo Yoon.

References

[1] F. Depisch et al, "Overview of results of INPRO phase 1A", ICONE-11, April 2003

[2] J. Kupitz, "International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)", ICAPP03, **3110,** May 2003

[3] IAEA-TECDOC-1362, "Guidance for the Evaluation of Innovative Nuclear Reactors and Fuel Cycles, Report of Phase 1A of INPRO", June 2003

[4] R. Steur et al, "The status of the INPRO and the ongoing activities of the phase 1B of INPRO", ICONE-12, April 2004

[5] IAEA-TECDOC-1434, "Methodology for the Assessment of Innovative Nuclear Reactors and Fuel Cycles", December 2004

[6] F. Depisch, Y. Sokolov, et al., "The IAEA International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO): Status and Outlook", ICONE-14, **89638**, Miami, USA, July 2006

[7] A. Omoto, "International Project on Innovative Nuclear Reactors and Fuel Cycles", 15th PBNC, October 2006

[8] G8 Summit statement, "Global energy Security", 16 July 2006 St. Petersburg

[9] F. Depisch, P. Florido, et al, "An example of an INPRO assessment of an INS in the area of economics" ICONE-14, **89639**, Miami, USA, July 2006

[10] B. Raj, Y. Busurin, et al, "An example of an INPRO assessment of an INS in the area of safety of fuel cycle Installations" ICONE-14, **89850**, Miami, USA, July 2006

[11] M. Moriwaki, R. Dones, et al, "Development of INPRO methodology in the area of Environment", ANS Transactions, **94**, 269-271 (2006)

[12] F. Depisch, C. Allan, et al, "An example of an INPRO assessment of an INS in the area of waste management" ICONE-14, 89640, Miami, USA, July 2006

[13] A. Vasile, G.L. Fiorini, et al, "Assessment of a French scenario with the INPRO methodology", ICAPP06, **6329**, Reno, USA, June 2006

[14] http://www-crp.iaea.org

[15] http://www-tc.iaea.org/tcweb/

[16] Statute of IAEA, http://www.iaea.org/About/statute.html