SUPPORTING INNOVATION
INTERNATIONAL PROJECT ON INNOVATIVE NUCLEAR REACTORS & FUEL CYCLES MOVES INTO FIRST PHASE

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Work has been initiated through the IAEA's International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), including technical meetings and workshops scheduled over the coming months. Among activities is an information "side event" on INPRO at the IAEA General Conference in September 2001.

From August to November 2001, several technical meetings and workshops are planned. Among topics being addressed are user requirements and nuclear development criteria in the area of safety (August); safety issues related to waste management technologies of innovative nuclear reactors and fuel cycles (September); methodology of assessment and comparison of innovative nuclear technology with respect to INPRO (September); user requirements on environmental impacts of innovative reactors, fuel cycles, and waste management (October); and user requirements and nuclear energy development criteria in the area of non-proliferation and proliferation resistance (November).

In December 2001, the second meeting of the INPRO Steering Committee is scheduled. The Steering Committee held its inaugural meeting earlier this year in Vienna, from 23-24 May. At that meeting, members stressed the unique role of INPRO relative to other national and international initiatives on innovative nuclear power technologies. The role lies in (1) identifying the needs and requirements of a spectrum of developing and developed countries; and (2) contributing explicitly to the debate on the global acceptability of nuclear power.

As of August 2001, the following countries or entities have become members of INPRO: Argentina, Canada, China, France, Germany, India, Netherlands, Russian Federation, Spain, Turkey, and the European Commission. In total, 14 experts have been nominated by their respective governments or international organizations.

INPRO members are those who contribute either cash or cost-free experts to the project. All IAEA Member States are also free to participate in the Steering Committee as observers.

INPRO Background. The IAEA General Conference in September 2000 invited "all interested Member States to combine their efforts under the aegis of the Agency in considering the issues of the nuclear fuel cycle, in particular by examining innovative and proliferation-resistant nuclear technology". In response to this invitation, the IAEA initiated the International Project on Innovative Nuclear Reactors and Fuel Cycles, or INPRO.

At a meeting of senior officials from Member States and international organizations 27-28 November 2000, the objectives and conditions of the project were discussed and the Terms of Reference were finalized. They stipulated that INPRO will be implemented by an International Coordinating Group (ICG) for which operating guidelines were adopted.

About 25 Member States and international organizations participated in the meeting. Several participants announced that their governments intend to make an extrabudgetary contribution to the project. The project was initiated once sufficient resources were made available by participating Member States.

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INPRO Rationale & Objectives. The Terms of Reference define INPRO's rationale and purpose, in the context of energy needs and developments. They state that the "long-term outlook for nuclear energy should be considered in the broader perspective of future energy needs and environmental impact. In order for nuclear energy to play a meaningful role in the global energy supply in the foreseeable future, innovative approaches will be required to address concerns about economic competitiveness, safety, waste and potential proliferation risks."

At the national level, work on evolutionary and innovative approaches to nuclear energy reactor design and fuel cycle concepts is proceeding in several IAEA Member States. At the international level, the IAEA, NEA and International Energy Agency of the OECD are cooperating to review ongoing R&D efforts on innovative reactor designs and to identify options for collaboration. The US Department of Energy is promoting the Generation IV International Forum (GIF)

KEY IAEA ROLE IN PEBBLE BED MODULAR REACTOR PROJECT

In 2000, the Pebble Bed Modular Reactor (PBMR) Project reached the status of an international consortium for the development and deployment of an innovative nuclear reactor concept. David Nicholls, Chief Executive Officer of the consortium, PBMR(Pty) Ltd, has made it clear that the effort would not have succeeded without the IAEA'S involvement and support. This successful experience can serve as a model for future IAEA efforts to facilitate the development of innovative nuclear technology. Thus it is important to understand how this commendable outcome was achieved.

Beginning in 1993, Eskom, the South African national electrical utility, initiated a study of concepts for future power generation in South Africa, addressing both nuclear and non-nuclear options. In September 1995, after initial results of the study indicated that modular high temperature gas cooled reactor (HTGR) technology was a leading prospect, Eskom contacted the IAEA Nuclear Technology Development Section (NPTDS), and requested support for their efforts. They were looking for further information on the technology and introductions to leading professionals knowledgeable in the technology around the world.

They had come to the right place. Fostering international information exchange and facilitating the development of professional relationships among world leaders in nuclear power technology development are primary objectives of NPTDS.

Discussions with Mr. Nicholls regarding his view of the IAEA's contributions to the PBMR effort identified the following specific areas of support:

■ International Networking. During the early stages of the Eskom feasibility study, Eskom employees participated in many IAEA meetings, including the International Working Group on Gas-Cooled Reactors (recently renamed the Technical Working Group on Gas-Cooled Reactors). This contact with some of the leading gas-cooled reactor technology experts in Member States evolved in many cases to bilateral relationships for advice, component development support, technology transfer agreements, etc.

■ Development & Deployment. The IAEA's information exchange meetings and coordinated research projects (CRPs) over the past decades have brought together international experts who have worked to reduce uncertainties in key areas. For example, three recently completed CRPs addressed generic modular HTGR characteristics with regard to the three key safety functions (controlling reactor power, cooling the fuel, and containing radioactive materials). These and other IAEA activities substantially reduced the risk that the PBMR project would be stopped or strongly impacted by fundamental technology limitations.

■ Independent & Objective Source of Information & Evaluation. During 1999 and early 2000, the IAEA conducted two reviews of the PBMR project at the request of the South African government. Issues of technology readiness, design approach and adequacy, economics, safety and safeguards were reviewed by teams composed of international experts and IAEA personnel from the Nuclear Energy, Nuclear Safety, and Safeguards Departments. The results of these inter-departmental reviews provided support for the April 2000 decision by the South African government to approve continuation of the design activities and initiation of an environmental impact assessment.

initiative, in which both the IAEA and NEA are participating as observers.

The President of the Russian Federation, at the Millennium Summit, called upon IAEA Member States to join their efforts in creating an innovative nuclear power technology to further reduce nuclear proliferation risks and resolve the problem of radioactive waste.

While existing national and international activities on innovative approaches play an important role, they are in most cases more limited in terms of scope, participation or timeframes. Against this background, and taking account of the IAEA's unique mandate in the fields of nuclear technology, safety and safeguards, the IAEA General Conference invited

participation in an international cooperative project.

INPRO's objectives, as defined in the Terms of Reference, are:

- 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 Member States, both

As the Eskom study proceeded and became more focused on modular HTGR technology, the level of resources applied to the project steadily increased. The growing level of interest and activity in South Africa became apparent to other IAEA Member States through Eskom's increasingly substantive participation in IAEA gas-cooled reactor meetings. This in turn stimulated greater interest and activity in the technology in other Member States.

As the initiative proceeded, Eskom began to explore prospects for adding partners to increase the financial and technical depth of resources available to the project. In late 1999, the Industrial Development Corporation, a quasi-government South African venture capital organization, completed its due diligence efforts and decided to join Eskom in the PBMR's development. In 2000, British Nuclear Fuels, Ltd (BNFL), an international company based in the United Kingdom with nuclear fuel manufacturing and nuclear power plant design and operation capabilities, also decided to join the venture. In parallel, Exelon Corporation, a large electricity generating company based in the United States with a long history of pioneering efforts in nuclear power technology, also decided to join, and PBMR(Pty) Ltd was formed to pursue the enterprise.

The consortium's formation by recognized world leaders in nuclear power plant design and operation has stimulated increasing interest and activities in modular HTGR technology development around the world. Industry-supported concept development and future deployment feasibility studies have been initiated in Japan and China to complement their research reactor efforts. The Gas Turbine Modular Helium Reactor (GT-MHR) development effort continues in the Russian Federation in collaboration with the United States, France, and Japan. The European Commission has greatly increased its support for modular HTGR technology development through the 5th Framework research and development programme.

Modular HTGR designs rely on passive and inherent features in conjunction with coated particle fuel to achieve a high level of safety without reliance on powered active systems. They are widely recognized as innovative concepts for possible future deployment. Coupling these features with state-of-the-art gas turbine, heat exchanger, and electronics technology adds to the innovative nature of the designs under development. Thus by acting as a facilitator for the PBMR project, the IAEA has played a vital role in the international development of an innovative nuclear power technology.

As interest in development and deployment of nuclear power continues to grow, other technologies can be expected to move toward deployment as well. Following the model of the PBMR project, the IAEA can contribute to the success of other initiatives by continuing to:

- function as a catalyst for international networking through well planned and executed international meetings;
- reduce the uncertainties associated with innovative nuclear power development and deployment through facilitation of CRPs conducted by Member States to address major issues;
- support the decision process of governmental agencies by serving as an independent source of information on and evaluation of innovative designs.

As the PBMR case has shown, such support can greatly enhance the prospects for successful future development and deployment of innovative nuclear power technologies of all types. -- *Contributed by James Kendall, an IAEA staff member in NPTDS.*

technology holders and technology users, to consider jointly the international and national actions required to achieve desired innovations in nuclear reactors and fuel cycles that use sound and economically competitive technology, are based – to the extent possible – on systems with inherent safety features and minimise the risk of proliferation and the impact on the environment;

- to create a process that involves all relevant stake holders that will have an impact on, draw from, and complement the activities of existing institutions, as well as ongoing initiatives at the national and international level.

Project Framework. INPRO is an Agencywide project, with contributions from all relevant IAEA Departments within available resources.

The framework for implementation of the Project consists of the following:

- a Steering Committee, comprising as members, senior officials from Member States that participate through provision of extra-budgetary resources and, as observers, representatives from interested Member States and international organizations. IAEA project management also is represented. The Steering Committee meets as appropriate to provide overall guidance, advise on planning and methods of work and review the results achieved;
- an International Coordinating Group (ICG), comprising cost free experts from participating Member States, which coordinates and implements the Project;
- Technical Expert Groups, comprising experts from Member States, which will be convened as appropriate by the ICG to consider specific subjects;
- support from the IAEA, including project management, administrative and technical support.

Project Phases. The Project will be implemented in two phases. Phase I was initiated in early 2001 and is planned to run to 2003. In the first phase, work will proceed in five subject areas recognized as important for the future development of nuclear energy technology, and on two parallel tracks.

The five subject areas are: resources, demand and economics; safety; spent fuel and waste; non-proliferation; and environment.

The two tracks are:

- *Track 1:* selection of criteria and development of methodologies and guidelines for the comparison of different concepts and approaches, taking into account the compilation and review of such concepts and approaches; and determination of user requirements in the subject areas.
- *Track 2:* examination of innovative nuclear energy technologies made available by Member States against criteria and requirements.

Joint Study. The experts already made available to INPRO have broad expertise and experience. They are professionals in areas of nuclear energy and fuel cycle technology, nuclear safety, economics and nuclear non-proliferation. These experts form the ICG, which was established earlier this year at IAEA headquarters in Vienna for an initial duration of two years.

The ICG has received input from the on-going Three-Agency Study (jointly conducted by the IAEA, the Nuclear Energy Agency, and the International Energy Agency of the Organization for Economic Cooperation and Development) on "Innovative Nuclear Reactor Development Opportunities for International Cooperation". The Group also interacts with other national and international stakeholders, in particular with NEA and the Generation IV International Forum (GIF), in order to ensure effective co-ordination and cooperation in a complementary manner.

Upon successful completion of INPRO's first phase, taking into account advice from the Steering Committee, and with the approval of participating Member States, a second phase of INPRO may be initiated. Drawing on the results from the first phase, it would be directed at:

- examining in the context of available technologies the feasibility of commencing an international project; and
- identifying technologies which might be appropriate for implementation by Member States of such an international project. ❐

To keep track of INPRO, visit the Project's Web pages on the IAEA's WorldAtom Internet site. The Project pages are accessible from the home page of the Nuclear Power Technology Development Section at http://www.iaea.org/programmes/ne/nenp/nptds/inpro