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An INIR mission team in Belarus

INIR Missions: Building Confidence for New Nuclear Power Programmes

Several countries have made a decision to start a nuclear power programme in recent years. The IAEA has been providing them with integrated assistance across a wide range of infrastructure areas. The Integrated Nuclear Infrastructure Review (INIR) missions are a key component in assessing infrastructure status and identifying areas for further action.

INIR missions have been conducted to Bangladesh, Belarus, Indonesia, Jordan, Thailand, the United Arab Emirates (UAE) and Vietnam since the mission was established in 2009. In 2013, INIR missions are planned to South Africa — the first country with an operating nuclear power programme that has requested this service — Poland and Turkey. Bangladesh and Jordan may consider follow-up missions while other countries such as Egypt, Kenya, Malaysia, and Nigeria have also expressed interest in receiving this mission.

The INIR Mission is an integral part of the IAEA's Milestones approach, which comprises three phases of development of a national nuclear infrastructure programme and covers 19 infrastructure issues, ranging from a government's national position on nuclear power to the procurement of items and services for the first nuclear power plant (*see Box p. 4*).

The end of each phase is marked by a 'milestone', i.e. when a country is making the decision to move forward with nuclear power (Milestone 1), as a follow-up review of progress and before initiating the bidding process (Milestone 2), and at the end of phase three, when a country is ready to commission and operate its first nuclear power plant (Milestone 3).

"The INIR Mission can support Member States in building confidence that their national infrastructure is adequately established, by identifying areas which need further recommendations on progress towards the next milestone", explained JK Park, Director of the Division of Nuclear Power, who has been the IAEA team leader for most INIR Missions.

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Message from the Director

Welcome to the first issue of the Nuclear Power Newsletter in 2013.

The 56th IAEA General Conference was held successfully in September 2012. The Division of Nuclear Power had organized five side events on key activities including those related to the implementation of the IAEA Action Plan on Nuclear Safety: Nuclear Energy for Energy Security, jointly organized with Planning and Economic Studies Section; Enhancing Global Nuclear Energy Sustainability: Briefing on INPRO; Nuclear Operator Organization Cooperation Forum; Integrated Approaches to Nuclear Work Force Development; and Roles and Challenges of Future Owners and Operators in Countries Embarking on Nuclear Power. The Division's work was also prominently represented at the exhibition booth of the Department of Nuclear Energy. I would like to express my sincere appreciation to all participants for their interest, and to our staff for their hard work in preparing these events.

Among other major activities during the past few months were preparations of the Programme and Budget for 2014–2015, interactions with international initiatives and organizations including OECD/NEA and GIF, the Phase 2 Integrated Nuclear Infrastructure Review (INIR) mission to Vietnam in December 2012, a pre-INIR mission to the Republic of South Africa and an introductory meeting for nuclear infrastructure development in Turkey. In cooperation with the China Atomic Energy Agency, a technical meeting on strategic partnerships for the expansion of nuclear power programmes was held in Beijing in October, and a meeting on stakeholder involvement in nuclear power was organized jointly with FORATOM. An education and training seminar in Argentina focused on fast reactor science and technology. Also, the nuclear energy system assessment currently undertaken by Indonesia was reviewed during a meeting in Indonesia in October 2012.

I would like to extend my sincere congratulations to the recipients of the 2012 IAEA service awards: Ms Anne Starz received a Superior Achievement Award; Merit Awards were given to Mr Masahiro Aoki, Mr Ibrahim Khamis and Mr Pal Vincze. Twenty-one staff members from the Departments of Nuclear Energy, Nuclear Safety and Security, Nuclear Sciences and Applications, Technical Cooperation, and the Office of Legal Affairs received a Team Award for their contributions to Integrated Nuclear Infrastructure Development.

We welcome several new colleagues in the Division, who have joined us during the past few months: Mr Zoran Drace (Acting INPRO Group Head) and cost-free experts from Member States including Mr Jin Kwang Lee (INIG), Mr Keeyoung Kim and Ms Jana Roeschlova (both NPES) and Mr Jon Philips (INPRO).

In this issue, several colleagues will introduce their home towns: Ms Jaana Isotalo introduces Rauma in Finland, Mr Stefano Monti presents the ancient town of Faenza in Italy, and Mr Hadid Subki highlights the sights of Bandung in Indonesia.

I wish you all a peaceful and prosperous year 2013.

Jong Kyun Park

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By providing a comprehensive assessment of all facets of a nuclear power programme, spanning the regulatory body, utility and all relevant government stakeholders involved, INIR is a valuable tool for promoting transparency and openness. This was also recognized as an important element of the IAEA Action Plan on Nuclear Safety, in the actions for embarking countries.

The INIR Mission is a holistic IAEA coordinated peer review, requested by the host country. It can assist the Member State in developing the infrastructure necessary for the introduction of nuclear power, evaluate the development status according to the 19 issues, identify gaps and areas where further work is needed to reach a given milestone and make recommendations and specific suggestion for progress.

INIR Mission Team

"The INIR Mission is conducted by a multidisciplinary team of experts who have experience in different aspects of developing and deploying nuclear infrastructure" said Anne Starz, Head of the Integrated Nuclear Infrastructure Group, which is responsible for the mission. "In my experience as team coordinator for several missions, delivering the final INIR Mission report to a high level in the Government can ensure that the cross-cutting recommendations are meaningful and useful to the country as it makes progress toward nuclear power."

To benefit from the expertise available in countries with nuclear power programmes and add to a pool of expertise, the IAEA has recently requested Member States to identify senior experts from national regulatory bodies, nuclear operating and other relevant organizations, who can share their experience with 'newcomer' countries. ***Continued on p. 4***

The Nuclear Power Interview

***Alexander Bychkov**, IAEA Deputy Director General, Head of the Department of Nuclear Energy, talks about the integrated services the IAEA offers to Member States in nuclear energy systems development.*

Q: Mr Bychkov, what are the services that the IAEA offers to Member States?

AB: The IAEA, through the Department of Nuclear Energy, has developed three complementary approaches — which we call 'integrated services' — to meet requests from Member States concerning nuclear energy development and deployment.

First, we assist Member States in building national capacities in energy analysis and planning so that countries can make knowledgeable decisions on energy supply options and assess the potential contribution of nuclear power in securing affordable and clean supplies of energy. Many countries have national institutions which can develop national energy plans without our participation, but some do request our assistance. We have a number of good programmatic instruments for energy planning which consider socio-economic, political, environmental and other aspects. I would like to underline that energy planning must be the first step towards a nuclear power programme. In short, we help countries to define the optimal energy mix and sometimes we recommend postponing the start of a national nuclear power programme.

Q: Why would the Agency recommend a country to postpone its nuclear power programme?

AB: There may be several reasons, for example insufficient power grids, lack of skilled human resources or no compelling economic or political reasons to start a nuclear programme at a given point in time. Some countries may decide to postpone the start of nuclear power programme and to look into the nuclear option in the future. But this is the decision of the Member State.

Q: And the other two approaches are?

The IAEA supports Member States in building the national nuclear infrastructure necessary for new nuclear power programmes. This begins with the establishment of a strong national position on the potential role of nuclear energy in the national energy mix. The IAEA's 'Milestones' approach provides Member States with a methodology they can use to mark progress during the planning stages and to demonstrate their commitment to nuclear safety and control of nuclear materials. An Integrated Nuclear Infrastructure Review (INIR) mission is a relatively recent and very effective service that helps embarking countries to assess their own progress and ensure that all elements necessary for the safe, responsible and sustainable use of nuclear technology are included.

Third, we assist Member States in developing long term strategic plans for nuclear energy development, including technical and institutional innovations. We apply the INPRO methodology in national nuclear energy system assessments, or NESAs. This enables Member States to assess the proposed or current nuclear energy system holistically and from a long-term perspective to confirm its sustainability. NESAs can be conducted by countries with existing nuclear programmes, by those who wish to expand their programmes and by newcomer countries. They are very important for strategic analyses and decision-making.

We use these three approaches in an integrated way to assist Member States at different stages of development of their nuclear power programmes so that they can use nuclear energy in a safe, secure, responsible and reliable way.

Q: Can you give any practical example?

AB: Belarus is a good example of a country that makes use of this comprehensive, integrated approach. Belarus was very badly affected by the Chernobyl accident and many thought it would never start a nuclear power programme. However, the country requested IAEA technical cooperation support in energy planning and the Agency completed this analysis together with Belarussian specialists. Belarus also completed a NESA, and it hosted an INIR mission in 2012. I visited Belarus last October and presented the mission report to the Government. I believe that our assistance has been and will continue to be very useful for Belarus, as well as for many other countries.

Q: Some of these activities have been part of the Agency's programme for quite a while. So what's new here?

I would like to underline that through these services, we can now offer a holistic 'package' which covers all aspects of a Member State's preparation for a national nuclear power programme or for expansion of existing programmes.

These three approaches are like the three pillars of a system: first, we address the issue of energy supply, taking into account environmental and economic aspects – this is the work of the Planning and Economic Studies Section. Then, we have strategic considerations over a longer period, using the INPRO methodology to assess all aspects of a nuclear energy system for its sustainability, which is the work of the INPRO Group. Third, we have nuclear power infrastructure development and the INIR missions to assist countries in preparing for their first nuclear power plant; this is coordinated by the Integrated Nuclear Infrastructure Group and involves experts from across the Agency.

The three services combine the existing nuclear knowledge that comes from both the IAEA and the Member States. And here, nuclear knowledge management also plays a key role in assisting Member States in managing nuclear energy programmes efficiently and effectively.

Interview by Elisabeth Dyck, Newsletter Editor

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National Self-Evaluation – A Pre-Requisite for the INIR Mission

To effectively prepare for an INIR mission, the Member State is requested to carry out a self-evaluation, considering all 19 infrastructure issues. The self-evaluation process is usually managed by the national authorities responsible for the new nuclear power programme and involves national experts involved in the programme from a wide range of institutions. Following such a self-evaluation, Member States are encouraged to arrange an independent review of their evaluation.

INIR Missions Conducted

Each INIR mission is tailored to the national circumstances and needs, but certain common challenges have been identified, in particular the legislative framework, national workforce planning and human resource development, management and management systems and stakeholder involvement.

Jordan was the first country to undertake a self-evaluation in 2009 and subsequently hosted the first INIR mission of the IAEA. "Jordan benefitted from the self-evaluation and INIR mission because it helped us identify issues and focus on future areas for assistance", said Dr. Kamal Araj, Vice Chairman of the Jordanian Atomic Energy Commission. Jordan also invited a follow-up mission in early 2012 to review its action plan.

Indonesia, Vietnam and Thailand hosted INIR missions covering Phase 1 conditions in 2009. Vietnam hosted a Phase 2 INIR mission in December 2012 "The process of making a self-assessment has great value for the planning and implementation of the nuclear power infrastructure development programme of Vietnam", said Nguyen Viet Phuong from the Vietnam Atomic Energy Agency.

The UAE, which hosted an INIR Mission in January 2011, is furthest ahead and started construction of its first nuclear power plant at the Barakah site in July 2012. The country was also the first to request the IAEA to make the full text of the INIR mission report open to the public. "The UAE considers the INIR mission an important milestone for its civil nuclear energy programme", said Ambassador Hamad Al Kaabi, the UAE´s Permanent Resident Representative to the IAEA, and emphasized the importance of being open and transparent. The first unit of the APR1400 technology supplied by a Korean consortium led by KEPCO is scheduled to be in operation in 2017, and three additional units are planned to be operational by 2020.

Bangladesh invited an INIR Mission in November 2011, which concluded that the country has met most of the conditions for knowledgeable decision-making and is actively preparing for the Rooppur Nuclear Power Plant project. "The mission team made 50 recommendations and 20 specific suggestions to assist the national authorities in preparing the infrastructure necessary to implement the project," said IAEA's JK Park, and Architect Yeafesh Osman, Minister of State of the Bangladesh Ministry of Science and ICT, emphasized the usefulness of the mission's results. A follow-up mission is planned for 2013.

In October 2012, IAEA Deputy Director General Alexander Bychkov presented the final report from the **Belarus** INIR mission to Deputy Prime Minister of Belarus, Anatoly Tozik. "Belarus has already implemented some of the recommendations that we shared with them after the INIR mission in June, and the government plans to implement all the remaining ones", said Mr Bychkov.

Poland requested an INIR mission planned for March 2013. "Poland plans to build two nuclear power plants with a total installed capacity of 6000 MW(e), and our objective is to start up the operation of the first nuclear power reactor around 2023", stated Hanna Trojanowska, Poland's Government Commissioner for Nuclear Power and Vice Minister of Economy during the 56th IAEA General Conference in September 2012. The IAEA has received a draft self-evaluation report and has begun mission preparations.

Most recently, **Turkey** has requested an INIR Mission. A plan for the mission was developed during a visit of senior IAEA experts to Ankara in November 2012 (see p. 5).

South Africa is the first country with an operating nuclear energy programme that will be hosting an INIR Mission in January 2013, to support the country's plans for nuclear power expansion.

IAEA Guidance Documents

References for the INIR are the IAEA publication *Milestones in the Development of a National Infrastructure for Nuclear Power* (IAEA Nuclear Energy Series No. NG-G-3.1), the evaluation methodology, documented in the publication *Evaluation of the Status of National Nuclear Infrastructure Development* (IAEA Nuclear Energy Series No. NG-T-3.2) and its recent *Addendum*, a booklet on *Guidance on Preparing and Conducting INIR Missions* (IAEA, 2011), other relevant IAEA publications, such as Safety Standards, as well as knowledge of good practices.

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The 19 Infrastructure Issues Considered in the Milestones Approach

- National position
- Nuclear safety
- Management
- Funding and financing
- Legislative framework
- Safeguards
- Regulatory framework
- Radiation protection
- Electrical grid
- Human resources development
- Stakeholder involvement
- Site and supporting facilities
- Environmental protection
- Emergency planning
- Security and physical protection
- Nuclear fuel cycle
- Radioactive waste
- Industrial involvement
- Procurement

More on...

Supporting Nuclear Infrastructure Development

IAEA Mission to Turkey

Turkey and the IAEA have agreed on close cooperation in the development of the national infrastructure for the country's new nuclear power programme.

Senior IAEA experts met with representatives from the Ministries of Energy and of Environment, the Turkish Atomic Energy Authority, the Energy Market Regulatory Authority and the Electricity Generation Company in Ankara on 6–7 November 2012.

The purpose of the IAEA mission was to share information about Turkey's ambitious nuclear energy plans and discuss the dedicated services which the IAEA offers to Member States embarking on a nuclear power programme.

Senior IAEA experts and representatives of the Turkish authorities met in Ankara in November 2012.

Turkey, which has considered nuclear power generation since the 1970s, now plans to introduce nuclear power into the country's energy mix, and is considering building three nuclear power plants to meet the rapidly increasing demand for electricity to support the country's economic development.

In 2010, Turkey and the Russian Federation signed an agreement for the construction and operation of the first nuclear power plant at the Akkuyu site in southern Turkey, as a BOO (build-own-operate) project. This would be the first BOO project worldwide for a nuclear power plant. The first of Akkuyu's four units, with a total capacity of 4800 MW(e), is scheduled to be commissioned in 2021. The second nuclear power plant site is Sinop on the Black Sea, and the third project is still under discussion.

Integrated Nuclear Infrastructure Review Planned

Turkey has requested the IAEA to schedule an Integrated Nuclear Infrastructure Review (INIR) in November 2013. The roadmap for the INIR mission was established during the meeting in Ankara, including IAEA assistance for the country's self-evaluation, preceding all INIR missions. The Ministry of Energy of Turkey is leading the project and will establish a team by the end of 2012. These activities and the INIR can be implemented under the framework of the Europe regional technical cooperation programme.

Turkey is also considering closer cooperation with the IAEA in the areas of economic modelling, public information and industrial involvement. These activities could also be implemented through IAEA technical coopeartion mechanisms, if needed.

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Becoming a Knowledgeable Customer

Providing recommendations and guidance to future owners/operators of nuclear power plants on how to become a knowledgeable customer was the aim of an IAEA workshop hosted by Electricité de France (EDF) in Paris on 5–9 November 2012. "This includes developing the capacity, competence and partnerships necessary for the successful planning, bidding, awarding and initiating the construction of a nuclear power plant", said Don Kovacic from the IAEA's Integrated Nuclear Infrastructure Group (INIG).

This capacity can then be used to help ensure the safe operation and maintenance of the nuclear power plant over the long term including emergency response and accident mitigation management. "The workshop was an opportunity for exchange of specific information, experiences, good practices, lessons learned and practical examples of how to become a knowledgeable customer" added Mr Kovacic.

After a policy decision has been taken to launch or expand a Member State's nuclear power programme, an appropriate organization, preferably the future owner/operator, should be charged with the responsibility to realize the commissioning of the nuclear power plant. Its responsibilities during the project will include soliciting and awarding bids, providing input to the design, managing siting issues, communication and stakeholder involvement, and construction, licensing and commissioning of the nuclear plant. After commissioning, the responsibilities will include operating, maintaining, and decommissioning the plant.

During this process, it is important for the future owner/operator to become a knowledgeable customer. A knowledgeable customer is defined as an organization that has achieved the competence and capacity to effectively manage and execute its responsibilities, which include dialogue and interfaces with the safety authority, entering into and managing contractual and commercial relationships with suppliers, vendors, and other entities during the whole life cycle of the plant. Knowledgeable customers know what to ask for, how to ask for it and how to know that they have received what they have asked for.

A wide range of countries attended the workshop, held in cooperation with the IAEA technical cooperation programme. Some are still considering whether to implement a nuclear power programme, others are actively working to implement it. Speakers came from experienced owner/operator organisations and their support organisations.

Senior experts gave definitions of the roles, requirements and key competencies of the knowledgeable customer. Countries that are working to develop a new nuclear programme stated their needs and asked probing questions.

Workshop on Becoming a Knowledgeable Customer, Paris, France, 5-9 November 2012 (Photo: S.Croix © EDF).

This was an interactive workshop that included three parallel working group sessions enabling the participants to discuss the interfaces between the knowledgeable customer and vendors, engineering organizations and national industry.

Real case studies covered the long term French/Chinese strategic relationship and the intergovernmental agreements between the Russian Federation and Turkey and Vietnam. Financing and legal issues related to addressing risk management were addressed, as well as developing a bid invitation specification.

Technical Tour to Flamanville

The workshop included a technical visit to the Flamanville Unit 3, which is currently under construction. It provided a fantastic opportunity to walk within the construction site and provide the participants with a real view of the complexity of such an enormous project.

"Despite its daunting nature, the participants could see the determination of the workforce to get the job done, with the end goal of producing valuable electricity for the benefit of their nation", said Don Kovacic.

Technical visit to the Flamanville construction site (Photo: EDF).

Participants confirmed that the workshop had been very beneficial and its format, which included presentations, panel discussions and smaller working groups, was appreciated. A similar workshop in planned for 2013 in the United Kingdom.

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The NEPIO's Role in New Nuclear Power Programmes

In the so-called 'newcomer' countries, a Nuclear Energy Programme Implementing Organization (NEPIO) may be formed to lead and manage the effort for consideration and subsequent development of a national nuclear power programme.

During Phase 1 of the IAEA Milestones approach (*before a decision to launch a nuclear power programme is taken*), the NEPIO prepares a comprehensive report on the 19 infrastructure issues, so that the government can make a knowledgeable decision on the introduction of nuclear power. In Phase 2 (*preparatory work for the construction of a nuclear power plant after a policy decision has been taken*), the NEPIO's role is shifted to increased coordination among key organizations, such as owners/operators, regulatory bodies and the government.

In order to share practical information on this coordination role, the IAEA convened a technical meeting in Amman, Jordan, in September 2012. Participants from Bangladesh, Belarus, Egypt, Jordan, Nigeria, Turkey and Vietnam discussed the roles and responsibilities of a NEPIO during Phase 2 of the IAEA Milestones approach.

Typically, the role of the NEPIO includes developing, driving and monitoring an integrated plan, exchanging information, coordinating, and decision-making in areas of national policy or in case of disagreement between organizations. In the course of Phase 2, the NEPIO's function may evolve as new, key national organizations start driving the programme themselves. However, the NEPIO continues to coordinate, since the government bears the overall responsibility.

The NEPIO should consider various means for establishing a regulatory framework for safety, security and safeguards, with adequate resources for the regulators. The emphasis on independent regulatory bodies should not lead to their

Participants in the IAEA Technical Meeting on the Role of a NEPIO, held on 3–5 September 2012 in Amman, Jordan.

'isolation' from the overall programme goals and plans. Advanced Phase 2 countries recommended that infrastructure issues be addressed by the NEPIO, whereas project issues would be resolved between the owner/operator and the regulatory body.

The role of the NEPIO in preparing for INIR missions, especially in conducting the self-assessment preceding a mission, in developing a national strategy for human resources, and in involving research institutes in nuclear power programmes were also intensively discussed.

Developing and implementing an appropriate nuclear infrastructure to support governmental decisions on nuclear power is crucial for all newcomer countries. This requires a high level of responsibility by the NEPIO. Hence, participants agreed that the Amman workshop served as an invaluable mechanism to share experiences on the role of a NEPIO and good practices needed to address the challenges faced.

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Nuclear Power Engineering

E-learning for Nuclear Newcomers

An extra-budgetary project, proposed and funded by the Republic of Korea in 2011, has enabled the IAEA, through INIG and the Nuclear Power Engineering Section, to develop e-learning modules for newcomer countries, based on existing IAEA publications on nuclear infrastructure development.

In the first phase, several e-learning modules are being developed. The first module is an overview based on the IAEA document '*Considerations to Launch New Nuclear Programmes* (GOV/INF/2007/2). The others cover topics such as stakeholder involvement, management of a new nuclear power programme and human resource management and are based on the IAEA Milestones publication (Nuclear Energy Series No. NG-G-3.1). Users should be able to complete the five modules in about 12 hours.

The goal of the project is to produce learning material, which is interactive and engaging. It will be suitable for 'one-off' learning and as a resource for future reference. The e-learning modules are targeted at a variety of stakeholders in Member States who are interested in, or embarking on a nuclear power programme, including decision makers, advisers and senior managers in governmental organizations, utilities, industries, and regulatory bodies, as well as donors, suppliers, nuclear agencies and operators. It will also enable others, e.g. students in the nuclear area to better understand the 'big picture' of developing nuclear power programmes.

The modules are developed according to international 'SCORM' (Sharable Content Object Reference Model) standards. They will be produced in mixed media formats and will be available for free during the second quarter of 2013, through different channels including the IAEA website, on CD-ROM and applications for mobile devices.

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Construction Readiness Review: A New Service for Member States

The construction phase of a nuclear power plant is where the art and science of designers is turned into a physical entity. Improper readiness for construction can result in nuclear plants experiencing both technical and financial problems from improper plant configuration, increased costs, and schedule delays.

The IAEA is developing a service for Member States to help governments, regulators, owners or constructors assess the readiness to proceed with a nuclear power plant construction project. The service, to be entitled 'CORR' for Construction Readiness Review, will consist of review missions conducted by a team of international experts. Reviews will be based on appropriate IAEA documents, such as Safety Guides and Nuclear Energy Series Reports, as well as on internationally recognized project and construction management guides. The mission's findings will be summarized in a mission report, including recommendations, suggestions and identified good practices. Reviews would be possible for both new build and for major plant refurbishment/retrofit projects. Currently, the CORR guidelines are being developed.

The review is not intended to be a regulatory inspection or an audit against international codes and standards. Rather, it is a peer review aimed at improving implementation processes and procedures through an exchange of technical experiences and practices at the working level. The mission is applicable at any stage of a construction project for a nuclear power plant, although two specific phases are targeted: a 'start of construction mission' (Phase 1 Mission) and an 'in-progress/start of commissioning' mission (Phase 2 Mission). Missions can be initiated upon a formal request from an organization in a Member State through official IAEA channels.

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Safety Assessments of Operating Nuclear Power Plants

Rigorous assessments have been conducted worldwide to evaluate the technical and organizational status of operating nuclear power plants with respect to nuclear safety, following the accident at Tepco's Fukushima Daiichi nuclear power plant Identifying potential improvements and weaknesses in the design robustness and institutional effectiveness in the light of the lessons learned from the accident were main objectives.

At a technical meeting on 'Safety Assessment of Operating Nuclear Power Plants', organized jointly by the IAEA and the Institute of Energy and Transport of the EC's Joint Research Center on 3–5 December 2012 in Petten, in the Netherlands, 30 experts from operating and regulatory organizations in 15 IAEA Member States discussed international experiences, challenges and their solutions that will help nuclear power plants to implement the assessments' recommendations.

In particular, they addressed the results of EU and non-EU safety assessments (stress tests); the IAEA Action Plan on Nuclear Safety; IAEA's Methodology for Assessment of Safety Vulnerabilities of Nuclear Power Plants Against Site Specific Extreme Natural Hazards; actions derived from safety assessments and implementation strategies; and verification of the effectiveness of completed actions and their incorporation in the design/licensing basis, as applicable.

"It's the Member State's responsibility how to follow up on the outcome of those assessments, and decisions on individual installations remain a responsibility of the operating organizations", said Ki Sig Kang from the IAEA Nuclear Power Engineering Section, adding: "It will be a long term process with challenges to the operating organizations to implement these additional measures; however, these challenges are understood and being managed by the operators and regulators in the Member States."

All of the plants have assessed the needs for potential safety improvements as a consequence of the lessons learned from the Fukushima accident, and many have already implemented substantial amount of actions. In many plants, special stationary or mobile equipment, to ensure the performance of prevention and mitigation functions, have been procured or installed. These additional components, such as electrical power supply and heat removal equipment, ensure diversity and redundancy. Furthermore, nuclear power plants have extensively reviewed and verified their design bases for the applicable external events learned from the Fukushima accident, such as flooding and earthquake.

International experts discussed safety assessments of operating nuclear power plants in Petten in early December 2012.

Borselle Nuclear Power Plant in the Netherlands. (Photo: TRACTEBEL Engineering)

Some operating organizations had proactively taken such measures well before the Fukushima accident. For example, the Borssele Nuclear Power Plant in the Netherlands already installed safety improvements in the 1980s and 1990s as a result of periodic safety reviews, and continuously updates the accident response processes, including the role of operators and on-site and off-site emergency responders before Fukushima accident.

As an outcome of the meeting, the IAEA is requested to develop guidelines on specific areas including management of severe accident mitigation, and to hold similar meetings with operating organizations periodically.

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Strategies for the Expansion of Nuclear Power Programmes

The expansion of a nuclear power programme in a country and its successful implementation are largely dependent on the established national infrastructure covering a wide range of activities and capabilities. Formalized strategic partnerships may contribute significantly to the strengthening of existing capabilities.

The IAEA, in cooperation with the China Atomic Energy Agency (CAEA), recently organized a technical meeting in Beijing to discuss strategies for the expansion of nuclear power programmes. "It is very important for the IAEA to support the expansion of national nuclear power programmes" said Mr Wang Minzheng, Director General of International Cooperation of CAEA.

"Most of the new nuclear power reactors which are planned or under construction are in Asia. Established users such as China, India, the Republic of Korea and the Russian Federation plan significant expansions of their nuclear power programmes, and developing countries continue to show keen interest in nuclear power" said Alexander Bychkov, IAEA

Opening Session of the IAEA/CAEA Meeting on Strategies for the Expansion of Nuclear Power Programmes, Beijing, China, 16–19 October 2012.

Deputy Director General for Nuclear Energy, in a video address. "The safe and economic expansion of a nuclear power programme requires a wide range of activities. The establishment of strategic partnerships is one of them", he added.

The meeting addressed experiences, benefits, risks, difficulties and challenges of building strategic partnerships in both established nuclear countries and 'newcomer' countries. These partnerships can be built, e.g. between the owner/operator of a nuclear power plant and the vendor or design authority for the plant, which needs to last for the entire plant life, or the owner/operator and suppliers of plant equipment, educational institutions, and major customers for electrical output.

Strategic partnerships can also be formed between the different regulators in a country, i.e. those responsible for nuclear safety, environmental protection and security and between nuclear regulatory bodies of the country where the nuclear power plant is to be built, the vendor country or other countries.

"It is not expected that there will be partnerships between the owner/operator of a plant and the regulators because of the need to maintain independence of the regulators, although the need for effective working relationships is fully appreciated", said Ms Xiaoping Li, who served as IAEA Scientific Secretary for the meeting.

The participants also reviewed two IAEA documents on nuclear power expansion and on strategic partnerships, to be issued soon, and recommended to consider initiating technical cooperation projects to support nuclear power expansion in Member States.

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Stakeholder Involvement in Nuclear Power Programmes

A technical meeting on Stakeholder Involvement in Nuclear Power: Developing Sustainable Relationships, Expanding Resources and Creating Value was organized by the IAEA in cooperation with FORATOM in October 2012. It brought together over 50 participants from 29 countries and four international organizations, representing a mix of nationalities from both newcomer and operating countries.

The meeting was organized following an increasing number of requests for assistance from IAEA Member States for support in stakeholder involvement and communication. Key sessions were classified under different, daily headlines:

- Effective stakeholder involvement principles;
- How successful is our dialogue with stakeholders?
- Monitoring communication impact.

Representatives from countries such as Poland, South Africa and Vietnam described their national perspectives on communication and public involvement plans, activities and challenges.

Tero Varjoranta, Director General of STUK, the Finnish regulatory body, discussed an entirely different aspect of nuclear power communication, namely, the fact that the definition of transparency and clarity, when interacting with various stakeholders, might be understood differently in different cultures.

"When communicating with stakeholders, it is more important to be 'understandable' than to be '100 percent correct'. We must therefore use language that is universally understandable when talking about a subject as technically complex as nuclear energy", said Mr Varjoranta.

Setsuko Inaki, from the Nippon Television Network Corporation in Japan, stressed that the media should be perceived as an asset for the nuclear power industry and emphasized that educational opportunities for journalists on nuclear energy topics would be useful.

Mr. Robert Knight of Ipsos Mori, United Kingdom, presented the results of an online poll completed in September 2012 on public opinion on nuclear energy in 24 countries. The results showed a positive change towards nuclear energy in most of the countries.

Participants from 29 Member States attended the Technical Meeting on Stakeholder Involvement in Nuclear Power, held at the IAEA 9–11 October 2012.

It was recommended that future meetings should also focus on areas such as communication with neighbouring countries, media training, and the use of social media.

Contact: Brenda Pagannone, NPES; B.Pagannone@iaea.org

PRIS Meeting

The Power Reactor Information System (PRIS) developed and maintained by the IAEA for over four decades, is a comprehensive database on nuclear power plants worldwide. PRIS contains information on power reactors in operation, under construction or those being decommissioned. In particular, it includes nuclear power plant specification data, design characteristics, decommissioning data, energy production and unavailability, outages and performance indicators.

The latest biannual Technical Meeting on PRIS was held at the IAEA in October 2012 and focused on the new PRIS public website, PRIS statistics and new modules of the database. Some 30 participants from 20 IAEA Member States and three international organizations, i.e. the OECD's Nuclear Energy Agency, the World Association of Nuclear Operators (WANO), and the World Nuclear Association, attended the meeting. Participants were designated technical liaison officers, national data providers and PRIS users from nuclear power plant and utility organizations, regulatory bodies and other national organizations.

The meeting agenda included all areas related to the system and included working group sessions to discuss selected topics, including the new public website, data reporting issues and a revision of the annual publication Operating Experience with Nuclear Power Stations in Member States. The participants recognized the services provided by PRIS to the nuclear industry and supported further enhancement and optimization of PRIS-related applications and outputs, particularly in view of current and future developments in, and requirements of, the nuclear industry. Maintaining and operating PRIS with quality data and the on-line reporting system (PRIS-Statistics) remains a high priority.

Closer cooperation has been established with WANO and using complementary IAEA and WANO performance indicators will improve performance monitoring and evaluations of nuclear power plants.

The PRIS public website is available at: http://www.iaea.org/pris.

Contact: Jiri Mandula, NPES; J.Mandula@iaea.org

PRIS Meeting, IAEA, 8−11 October 2012.

International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)

Moving Ahead with 'SYNERGIES'

The objective of the INPRO Collaborative Project on Synergistic Nuclear Energy Regional Group Interactions Evaluated for Sustainability (SYNERGIES) is to identify and evaluate mutually beneficial, collaborative architectures and the driving forces and impediments for achieving globally sustainable nuclear energy systems. Specifically, the project aims to identify short term (2012–2030) and medium term (2030–2050) collaborative actions to foster long term sustainability.

At the second project meeting held on 12−16 November at the IAEA, 18 participants and observers from 14 IAEA Member States reviewed recent progress made.

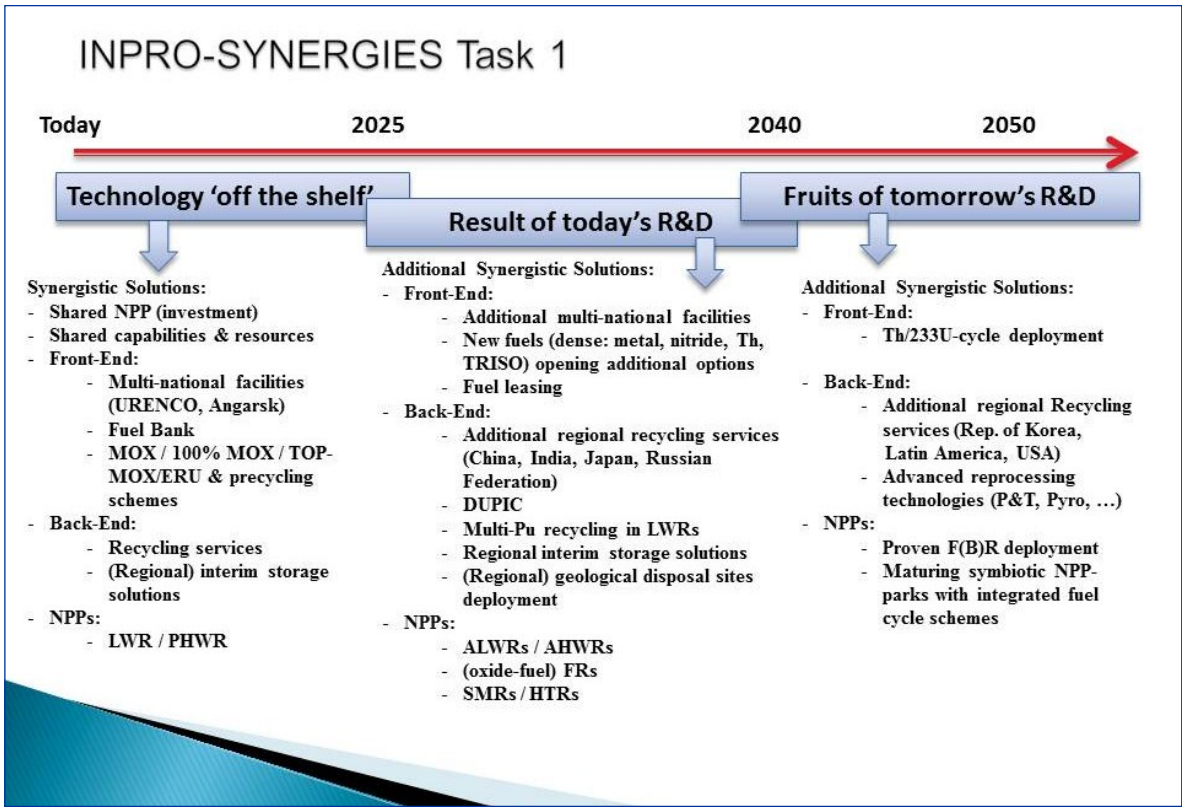
Task 1, led by France, covers nuclear fuel cycle synergies. It focuses on intra-regional studies of collaboration among countries, in line with an agreed-upon view of global nuclear energy system evolution – termed the 'SYNERGIES storyline' – which is structured in thee time periods:

Before 2025: This period focuses on short term issues and challenges countries may face, which should be addressed in a mutually beneficial, collaborative way, while also considering medium and longer term sustainability.

2025 to 2040: Various R&D trends pursued today, specifically those related to the nuclear fuel cycle and advanced nuclear energy systems may see varying degrees of commercialization over this period. This may become an issue of the highest importance for many countries, especially if it comes to bilateral/multilateral, regional, or even global collaboration.

After 2035: Some of the on-going or planned R&D activities may find commercial applications after 2035. Those might include additional collaborative solutions in the fuel cycle front-end for a ^{233}U-Th fuel cycle, and increased regional recycling services, advanced partitioning and transmutation technologies for waste management, deployment of proven fast reactors or fast breeder reactors, and maturing nuclear power plant 'parks' with integrated fuel cycle schemes. Geological disposal sites are likely to be under development or operational, and multi-lateral or regional deployment approaches would be of prime importance to secure a transition to globally sustainable nuclear energy systems.

"We discussed nine case studies to examine the driving forces and impediments for collaboration among countries in particular segments of the 'storyline', three case studies are on-going and six are newly proposed", explained Vladimir Kuznetsov from the INPRO Group, who is the Scientific Secretary of the SYNERGIES Project.



An interim report on the case study on 'Reactor synergy: an economic analysis of re-burning LWR Americium in a heavy water reactor', led by Canada, was presented, and the viability of such an approach was discussed. The Russian Federation has made substantial progress in intra-regional collaborative scenario studies, by leading a case study on synergistic options for regional cooperation on the nuclear fuel cycle, aimed at finding and quantifying 'win-win' approaches for such collaboration. Italy presented the ADRIA case study on regional cooperation in the deployment of innovative reactors, supported by a nuclear capable country which currently has a moratorium on domestic nuclear power applications. Front end and back end fuel cycle issues constitute an important part of this study.

Newly proposed case studies would focus on collaborative scenarios of U/Th recovery from Rare Earth industry waste for use in a nuclear power programme (Malaysia); synergies in transitioning towards a U/Pu/Th nuclear energy system (India); and collaborative scenarios of fast reactor application to spent nuclear fuel management (Japan) and others.

The Russian Federation leads **Task 2**; several studies of global nuclear energy scenarios not addressed earlier are now underway, such as a study on alternative fast reactor deployment scenarios (^{235}U load versus U-Pu load). The results of a study on the sensitivity of the scenarios developed in the GAINS project (Global Architecture for Innovative Nuclear Systems Based on Thermal and Fast Reactors including Closed Fuel Cycles), to global fractions of countries with different nuclear fuel cycle policies were presented at the meeting.

Task 3, 'Options for minor actinide management', performs comparative assessments of options for minor actinide transmutation/incineration, in scenarios dealing with global nuclear energy system growth and legacy waste minimization in countries which phase out nuclear energy.

India, who leads **Task 4,** developed a short list of possible additional key indicators and evaluation parameters for synergistic collaborative scenario evaluation, including economic assessment methods. Suggestions from the INPRO Dialogue Forum on Drivers and Impediments for Regional Cooperation on the Way to Sustainable Nuclear Energy Systems, held 30 July − 3 August 2012 at the IAEA, and other inputs were taken into consideration.

"We also had a very good brainstorming session on economic indicators and assessment methods", said Mr Kuznetsov. "Also, IAEA staff demonstrated several nuclear energy system models and codes, such as NFCSS, MESSAGE and DESAE 2.2". The next project meeting will be held 3−7 June 2013.

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New Collaborative Project ENV-PE Launched

To understand possible radiological impacts on the environment and human health, associated with the operation of any nuclear installation, two sources of risk have to be considered: the risk of health effects due to the release of controlled amounts of radioactive effluents to the environment, which are usually referred to as normal operation discharges, and the risk of health effects due to potential releases during nuclear accidents.

The new INPRO collaborative project on Environmental Impact of Potential Accidents Releases from Nuclear Energy Systems (ENV-PE) will provide a framework for assessing human health risks caused by potential radioactive releases in an accident scenario in a nuclear power plant. ENV-PE is a

follow-up project to the completed INPRO collaborative project on 'Environmental Impact Benchmarking Applicable for Nuclear Energy System under Normal Operation'.

A potential accident scenario will be defined as 'source term', including the associated probability and representative environmental data. Early and late health effects will be determined by applying environmental dispersion models dedicated to accidental releases and dose/effects functions.

The ENV-PE project was launched during a meeting at the IAEA on 10−12 October 2012. Experts from Argentina, Belarus, France, Germany, India, Indonesia, Israel, the Russian Federation, Spain and Ukraine participated and presented dose assessment methodologies applied in their countries.

International experts met at the IAEA in October 2012 to launch the new INPRO Collaborative Project ENV-PE .

The planned study will address issues such as accidental source term characteristics; selection and use of representative meteorological and environmental data; environmental (atmospheric, aquatic) dispersion models applicable to accidental releases; selection of representative persons for accidents (location, characteristic, habits, age); dose assessment (pathways, radionuclides, short-term and long-term doses); early and late health effects; consideration of countermeasures; use of dose/effects relations and risk factors; and selection and use of reference doses and risk constraints.

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PROSA Collaborative Project

Understanding and improving proliferation resistance and its strong dependency on effective and efficient Safeguards verification is crucial for the sustainable and responsible use of nuclear power. The INPRO Collaborative Project on **Proliferation Resistance and Safeguardability Assessment Tools** (PROSA) is developing a simplified set of self-assessment tools to better help users, including countries embarking on a nuclear power programme or those making longer term energy plans that include a nuclear energy system (NES).

The third PROSA project meeting was held 28–30 November 2012 at the IAEA. Experts from eight Member States and the European Commission discussed the preparation of an IAEA technical document that will simplify the explanation of the five User Requirements (UR) that support the Basic Principle (BP) in the assessment of proliferation resistance using the INPRO methodology. In brief, these URs are: 1 – State's commitments and undertakings, 2 – attractiveness of nuclear material and technology, 3 – 'safeguardability' of nuclear facilities, 4 – robustness of proliferation resistant features & measures, and 5 – cost optimization.

Proliferation Resistance Basic Principle:

Proliferation resistance intrinsic features and extrinsic measures shall be implemented throughout the full life cycle for innovative nuclear energy systems to help ensure that INSs will continue to be an unattractive means to acquire fissile material for a nuclear weapons program. Both intrinsic features and extrinsic measures are essential, and neither can be considered sufficient by itself.

From IAEA-TECDOC 1575 Rev.1, INPRO Manual Vol. 5: Proliferation Resistance

Some discussions revolved around the complexity of proliferation and safeguardability assessment. It was agreed to adjust the depth of the analyses, with particular attention on the needs of embarking States that are considering acquisitions of proven commercial technology. The usefulness of a comparison to a reference case was also agreed upon.

The participants agreed to address the less complex needs of technology users who are considering the implications of embarking on a nuclear program, while retaining the capability for more detailed analysis for users assessing more complex nuclear energy systems and those considering the development and deployment of innovative nuclear energy systems and novel technology.

The INPRO Collaborative Project PROSA benefits from a close cooperation with the IAEA Department of Safeguards and the Generation IV International Forum Working Group on Proliferation Resistance and Physical Protection.

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NESA Review Mission to Indonesia

Indonesia is progressing well with its nuclear energy system assessment (NESA), using the INPRO Methodology. In early October 2012, two experts from the INPRO Group reviewed Indonesia's draft NESA in a meeting with some forty national experts from the Indonesian Nuclear Energy Agency (BATAN), the Indonesian regulatory body (BAPETEN), the University of Gadjah Mada and experts responsible for the all assessment areas covered in the Indonesian NESA, i.e. economics, environment, infrastructure, reactor and nuclear fuel cycle safety, waste management, physical protection and proliferation resistance.

The review meeting was timely and assisted Indonesia in building the NESA scope and sophistication to serve as a basis for strategic planning and policy making in the future. "There is a strong commitment by the national experts to perform a high quality NESA study, to demonstrate the long-term sustainability of the planned nuclear energy system in Indonesia", said Andriy Korinny from the INPRO Group.

The Indonesian NESA team and members of the INPRO Group met at BATAN in Serpong 1–5 October 2012 to review progress in the NESA.

The NESA review mission provided an opportunity to discuss major results of the Indonesian NESA team and to make recommendations on the application of the INPRO Methodology for several specific criteria in all assessment areas.

"We discussed the complexity required to assess, regulate, manage and operate large scale commercial nuclear facilities", explained Jon Phillips from the INPRO Group. "The NESA process is a complete assessment of all the issues relevant to test the sustainability of existing and proposed nuclear energy systems. Properly performed, it can provide broader and deeper awareness of the nuclear power programme status", Mr Phillips added.

The Indonesian NESA has a complex scope, including mining, milling, conversion, import of enrichment services and initial cores of fuel assemblies, fuel fabrication, large light water reactors, small and medium sized reactors, on-site and away-from-reactor dry storage and waste disposition, repository and potential spent fuel returns. The study is in Stage 1 of four stages, i.e. familiarization with the NESA for all assessment areas of the INPRO methodology for a selected nuclear energy system, with the fourth stage being a full scope NESA.

The IAEA experts provided detailed advice on how to proceed to the completion of Stage 1. They also presented examples of previous NESA experiences, such as broad cursory assessments (Argentina and Ukraine) and a detailed NESA performed by an embarking country (Belarus). Since collecting input data from the designers of nuclear fuel cycle facilities has been identified as a major challenge, recommendations were made on how to collect the necessary data and develop relationships with potential technology providers. Ways to leverage preliminary nuclear site evaluations that are currently on-going in Indonesia were also suggested.

The NESA may help inform the current national policy debates on nuclear safety, environmental issues and waste management sustainability. In response to this NESA review mission, Indonesia will further refine its approach, collect the necessary data and complete Stage 1 of the NESA.

Nuclear Power Technology Development

Latest Developments in SMRs

The current IAEA programme on small and medium-sized reactors (SMRs) supports the IAEA Action Plan on Nuclear Safety and reflects renewed interest in Member States in this technology.

International SMR Development in 2012

In **Argentina**, construction of the 27 MW(e) CAREM-25 reactor has started, near the Atucha-2 site, and commissioning is expected by 2017.

In **China**, two modules of the high temperature reactor-pebble bed module (HTR-PM) are under construction. The China National Nuclear Corporation (CNNC) is developing the conceptual design for the ACP-100 rector.

The 150 MW(e) seabed-moored FLEXBLUE reactor concept, developed in **France**, was presented at the IAEA recently.

In **India**, four units of the pressurized heavy water reactor (PHWR-700) are under construction.

In July 2012, the **Korean** Nuclear Safety and Nuclear Security Commission has completed a review of, and awarded a Standard Design Approval for the 100 MW(e) SMART, developed by the Korea Atomic Energy Research Institute (KAERI).

The Russian Federation has almost completed construction plans for the KLT-40s dual 35 MW(e) reactors, to be used for a floating nuclear power unit. Commissioning will start in 2013. Also, construction of SVBR-100 and BREST-300 reactors is planned, and deployment is foreseen in 2017.

Recently, the **US** Department of Energy has selected the 180 MW(e) mPower™ reactor design to receive funding for a design review by the US Nuclear Regulatory Commission.

Recent IAEA Activities on SMRs

All of the above have resulted in increased activities at the IAEA, providing assistance to technology holders and countries interested in SMR technology, particularly nuclear 'newcomers'.

The IAEA Nuclear Energy Series Report **Options to Enhance Energy Supply Security using Hybrid Energy Systems based on Small and Medium Reactors (SMRs)** will be published soon. This report investigates the potential of SMRs in enhancing energy supply security and reducing greenhouse gas emissions, through synergizing the advantages of renewable energy resources such as wind, solar and geothermal with innovative SMRs. Through this effort, the IAEA attempts to combine the techno-economic research on energy use carried out by the Joint Research Centre of the European Commission (EC-JRC) and the implementation of conventional energy policy in various countries embarking on their first nuclear energy programme.

An IAEA project **Environmental Impact Assessment for SMR Deployment in Newcomer Countries** will assist Member States in the implementation of standardized processes through a smoother licensing process, reduced costs, enhanced public acceptance, and technically feasible impact assessments.

A meeting **Incorporating lessons learned from the Fukushima accident in SMR technology assessment for design of engineered safety systems**, with participation of India, Indonesia, Italy, Japan, Republic of Korea, Russian Federation and the USA, provided recommendations on lessons learned from the Fukushima accidents, to be incorporated into the design of advanced integral type water cooled SMRs, as well as on near term and long term international R&D activities in SMR technology development, and on the area of advanced engineered safety features designs and performance evaluation.

An upcoming report, to be published in the IAEA Nuclear Energy Series (NP-T-3.7) on '**Approaches for Assessing Economic Competitiveness of SMRs'** intends to assist stakeholders in understanding the economic competitiveness of SMR technologies, compared to other energy sources and large reactors. It presents available approaches, tools and frameworks to assess the economic competitiveness of SMRs and includes positive experiences of Member States who have introduced SMRs in their energy mix.

A **Toolkit for SMR technology assessment on the reliability of engineered safety features** was planned and designed at a meeting in September 2012 at the IAEA. Participants from China, Indonesia, Italy, Republic of Korea and the USA provided recommendations for safety system performance and risk management related to SMRs. This activity is funded by the US Peaceful Uses Initiative (PUI).

The second edition of the booklet on the **Status of Small and Medium-sized Reactor Designs, A Supplement to the IAEA Advanced Reactors Information System (ARIS)** was published. Much enhanced and including more images of SMR designs and updated information, it presents an overview of the status of SMR designs, such as reactor type, designer country, capacity and configuration and design status.

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Reactor Physics and Technology Development Activities

The American Nuclear Society (ANS) invited the IAEA to organize a special session on **IAEA Reactor Physics and Technology Development Activities** at the 2012 ANS Winter Meeting and Nuclear Technology Expo on Future Nuclear Technologies: Resilience and Flexibility. The meeting was held 12−15 November 2012 in San Diego, California, USA.

"The Department of Nuclear Energy, often in cooperation with the Department of Nuclear Sciences and Applications (NA), has a long tradition of undertaking nuclear research activities, in particular Coordinated Research Projects on Reactor Physics, for any kind of advanced and research reactors", explained Stefano Monti of the IAEA Nuclear Power Technology Development Section, who co-organized the Session with the IAEA Department of Nuclear Science and Applications.

The Special Session included presentations on the results of IAEA activities on nuclear data needs in fission, fusion and a variety of accelerator or research reactor-based applications, uncertainty analysis in liquid-metal and gas-cooled reactors, reactor physics in research reactors and subcritical systems, and advanced materials research using neutron beams.

Results of several Coordinated Research Projects, primarily dealing with verification and validation of advanced simulation tools through benchmarking against experimental data from existing research and sodium-cooled fast reactors, as well as accelerator driven system experimental facilities, were presented. Some 50 participants, mostly young scientists and engineers involved in related R&D activities, attended the special IAEA session.

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REMINDER!

www-pub.iaea.org/iaeameetings/41987/FR13

Seminar on Fast Reactor Science and Technology in Argentina

Currently, nuclear power represents 2.5% of Argentina's energy mix. However, the country is committed to the further development and deployment of nuclear energy and related technologies, and supports an intensive programme including two nuclear power plants in operation, one nuclear power plant under construction and one planned, a domestic small modular reactor (SMR) concept (CAREM), for which site excavation work has already started, several research reactors and significant R&D activities in all nuclear energy areas.

In particular, Argentina is considering advanced fast nuclear reactors for long term development and deployment of nuclear power. The Argentinian programme is mainly focused on monitoring global progress of technologies for Generation IV nuclear reactors and their fuel cycles, including basic studies and evaluations to define the most interesting Generation IV research lines for the country, setting up experimental facilities, and participation in specific international projects.

Argentina is one of the founding members of INPRO and the Generation IV International Forum, and an observer in the IAEA Technical Working Group on Fast Reactors.

To enhance national knowledge in the area of innovative fast neutron systems, Argentina's National Atomic Energy Commission (CNEA) hosted an **Education and Training Seminar on Fast Reactor Science and Technology,** organized by the IAEA and held at the CNEA Center of Bariloche 1-5 October 2012.

Some 100 Argentinian scientists and engineers involved in the various CNEA activities on reactor physics, nuclear engineering, fuel and materials research and technology development attended the seminar, which covered all types of fast reactors being developed worldwide, i.e. sodium-cooled fast reactors, lead-cooled fast reactors, gas-cooled fast reactors and molten-salt cooled fast reactors, as well as global scenarios for nuclear energy development, reasons for introducing fast reactors, common aspects of fast reactor technology, and national and international fast reactor development programmes.

"CNEA recognizes the important and increasing role that fast reactors are gaining worldwide in the field of nuclear power. One of the objectives of the current strategic plan of CNEA is to implement a follow-up program of the new Generation IV nuclear reactors, and their fuel cycles technologies", said Carlos Gho, Director of the Nuclear Energy Area of CNEA.

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Advancing Computer Codes for Heavy Water Reactors

Computer codes are used extensively by the nuclear industry for support of operations, reactor and fuel design, safety analysis, and other applications. "Various groups within the industry have recognized that our current analytical, scientific and design computer codes, which in many cases are based on development started some 25−30 years ago, are becoming increasingly difficult and expensive to maintain", said Jong Ho Choi of the IAEA Nuclear Power Technology Development Section. Also, advances in numerical techniques and computing resources that offer improvements in code accuracy and efficiency may at times be difficult to implement in current code suites. These considerations have led to various organizations and groups to begin developing advanced codes and code suites (also called tool sets) to replace the current codes.

The goal of developing an advanced code suite for nuclear applications, which consolidates the important functionality of the existing tools using modern software architecture and modular design, while providing user friendly interfaces and improved accuracy and quality, is ambitious. A collaborative development framework, in which several organizations could leverage their existing advanced tools and expertise, in exchange for developments from other organizations, would have several potential benefits: reduced code development costs for each organization, potential to develop highly trained staff through secondments, and the ability to share lessons learned, e.g., on code coupling requirements, nodalization schemes and data transfer architecture.

Experts on computer codes for design, safety analysis and operation of heavy water reactors (HWR) met in Ottawa, Canada in early October 2012 and addressed topics such as:

- Reactor Physics
- Thermal-hydraulics and Coupling with Physics
- Safety Analysis
- Fuel and Coupling with Physics
- International Collaboration

The experts agreed to give the highest priority to international cooperation in two areas:

(1) Argentina (PUMA), Canada (RFSP and new), India (IQS3D), the Republic of Korea (McCARD) and Romania (DIREN) have been developing their own reactor physics codes and coupling method with thermal-hydraulics codes. A benchmarking problem for reactor physics area would be helpful for all code developers, to increase the fidelity of their computer codes.

(2) The power coefficient of reactivity (PCR) for existing HWRs is changing with plant life. The inherent safety of nuclear power plants requires this PCR to be a negative value during the entire plant life. Recent predictions with new computer codes show a different result from the previous code system. Re-evaluation of PCR and related reactivity coefficients, and validation with plant data would be necessary to increase the reliability of physics codes.

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Prediction of Fuel Channel Deformation

Atomic Energy Canada Ltd. (AECL) is hosting an IAEA ICSP (International Collaborative Standard Problem) on '**Heavy Water Reactor Moderator Subcooling Requirements to Demonstrate Backup Heat Sink Capabilities of the Moderator during Accidents**'.

"An important safety feature of pressurized heavy water reactor is the ability to use the moderator as a backup heat sink during emergencies", explained Jong Ho Choi from the IAEA's Nuclear Power Technology Development Section.

In a number of postulated loss-of-coolant accident scenarios with or without coincident loss-of-emergency core cooling, the fuel may overheat and transfer heat to the pressure tube. As the pressure tube overheats, it loses strength, plastically deforms and balloons into contact with the surrounding calandria tube. At the time of contact, the calandria tube experiences a large increase in heat flux at the contact points as stored heat is rejected from the pressure tube to the cooler calandria tube. If the heat flux on the outer surface of the calandria tube exceeds the critical heat flux, film boiling (dryout) may occur on the surface of the calandria tube. If the area of dryout is sufficiently large and the dryout is prolonged, the pressure-tube/calandria-tube combination can continue to strain radially and may challenge fuel-channel integrity. The moderator subcooling limits required to avoid dryout conditions, which could challenge fuel-channel integrity, are defined by the contact boiling curve. The boundary between immediate quench and patchy film boiling defined the moderator subcooling limits for CANDU reactors.

The first workshop to share experiences and establish an international collaboration scheme for the ICSP was held 19−21 November 2013 in Ottawa, Canada. Ten organizations from Canada, India, the Republic of Korea, Pakistan, and Romania including research institutes, regulatory bodies, utilities and engineering companies are participating in this ICSP with several computer codes.

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Preserving Knowledge on HTGR Technology

The IAEA has developed a training course on high temperature gas-cooled reactor technology (HTGR) to ensure that knowledge on this rector type is preserved. The objective is to offer this course to universities with nuclear engineering programmes as an elective, and to achieve this, efforts will be made to have the course accredited by qualifications authorities in interested Member States. "This course can be offered in a series of modules, each module representing a particular aspect of the technology, and students can take up to one week to complete it", explained Bismark Tyobeka from the IAEA Nuclear Technology Development Section.

In October 2012, the Institute of Nuclear and New Energy Technology of Tsinghua University in Beijing, China, hosted a pilot training course, which was attended by 35 participants from 10 Member States. It covered topics including:

- Pebble-bed core neutronics design
- Pebble-bed thermal-hydraulics design
- Prismatic core neutronics design
- Prismatic core thermal-hydraulics design
- HTGR safety aspects and probabilistic safety assessment
- Graphite issues in HTGRs
- HTGR fuel development, manufacture and qualification
- Quality Control in HTGR fuel manufacturing
- Fission product transport modeling in HTGR fuel
- HTGR systems and components
- Process heat applications using an HTGR.

A technical tour of the Chinese HTGR test facilities, including the experimental reactor HTR-10, concluded this pilot course. There is increasing interest in HTGR technology, at least at the level of academics and researcher. "The participants showed great interest in this topic, since most of them come from a light water reactor background", said Mr Tyobeka.

To enable interested researchers to keep up-to-date with technology developments in HTGRs, it was recommended to hold this course at least once a year.

Contact: Bismark Tyobeka, NPTDS; b.m.tyobeka@iaea.org

Training Course on HTGR Technology—Challenges for Future Deployment, 22−26 October 2012, Beijing, China.

Nuclear Power Publications

Recently Published

- Efficient Water Management in Water Cooled Reactors (IAEA Nuclear Energy Series No. NP-T-2.6)
- Human Resource Development for Introducing and Expanding Nuclear Power Programmes: Summary of an International Conference, Abu Dhabi, United Arab Emirates, 14-18 March 2010 (STI/PUB/1574)
- Liquid Metal Coolants for Fast Reactors (Reactors Cooled by Sodium, Lead, and Lead-bismuth Eutectic) (IAEA Nuclear Energy Series No. NP-T-1.6)
- Nuclear Power Plant Life Management: Proceedings of an International Symposium Held in Shanghai, 15-18 October 2007 (STI/PUB/1362)

Coming Soon…

- Challenges Related to the Use of Liquid Metal and Molten Salt Coolants in Advanced Reactors (IAEA-TECDOC)
- Design Features and Operating Experiences of Experimental Fast Reactors (IAEA Nuclear Energy Series No. NP-T-1.9)
- Implementation of a Management System for Operating Organizations of Research Reactors: A Case Study (Safety Reports Series)
- Status of Hydrogen Production Using Nuclear Energy (IAEA Nuclear Energy Series No. NP-T-4.2)

Inside the Division of Nuclear Power

New on the Team

Zoran Drace, Acting INPRO Group Leader

Zoran Drace joined the Division as Acting INPRO Group Leader. Previously, he was Team Leader for predisposal management of radioactive waste in the Division of Nuclear Fuel Cycle and Waste Technology. Before joining the IAEA in 2006, Zoran worked for Ontario Power Generation (OPG), an electric utility company in Canada, where he held managerial positions related to nuclear waste management. He holds an MSc degree in nuclear engineering from the University of Belgrade. He is a licensed professional engineer (P.Eng.) in the province of Ontario, Canada.

Jon Rowan Phillips, Senior Nuclear Technology Expert, INPRO Group

Jon Phillips is in charge of INPRO's Project 1 on long-range nuclear energy strategies. Before joining the IAEA, he was Director of the Sustainable Nuclear Power Initiative at the US Department of Energy's Pacific Northwest National Laboratory. He has a PhD in Mechanical Engineering from Washington State University, USA.

Jin Kwang Lee, Senior Nuclear Infrastructure Expert, INIG

Jin Kwang Lee is responsible for the integration of IAEA training courses to assist embarking countries. He will work together with experts in human resource development, education and knowledge management. Previously, he worked for the Ministry of Knowledge Economy in the Republic of Korea. He played an important role in policy making in the areas of energy, industry and trade. He has a MA in electrical engineering from Seoul National University, and an MA in Public Management from Carnegie Mellon University in the USA.

Jana Röschlová, Management System Specialist, NPES

Jana is involved in activities related to integrated management systems, development of a web-based network as part of CONNECT and flowcharts for working processes in the Department of Nuclear Energy. Before joining the IAEA, she worked at Slovenske Elektrarne (Enel) in Bratislava, Slovakia, in an independent oversight team. She was involved in nuclear safety assessments of nuclear power plants in operation (Bohunice and Mochovce) and in the implementation of IAEA GS-R-3 Safety Requirements. She has a PhD degree in physical engineering from the Slovak University of Technology in Bratislava.

Keeyoung Kim, Nuclear Engineer, NPES

Keeyoung is involved in projects related to water chemistry control in nuclear power plants and supports several TC Projects on maintenance process and licensing renewal in Member States. Previously he was a senior manager at the Korea Hydro & Nuclear Power Company (KHNP), Republic of Korea. His expertise is in power generation, nuclear safety, and operation of nuclear power plants, acquired through practical experience. He has a MSc in nuclear engineering and holds a Senior Reactor Operator (SRO) license.

Superior Achievement Award 2012

Ms Anne Starz, Head of the Integrated Nuclear Infrastructure Group, is one of the recipients of the IAEA's Superior Achievement Awards in 2012. The IAEA recognizes "Ms Starz' contribution to IAEA's activities for countries embarking on nuclear power programmes as outstanding. She developed INIG in 2010 through extensive consultations with internal and external stakeholders. INIG has increased the effectiveness of the IAEA's support to countries introducing nuclear power. After the Fukushima accident, Ms Starz was a steady voice in support of nuclear power in developing countries. A specific achievement is the INIR service, developed under her leadership".

My Hometown

Rauma, Finland

By Jaana Isotalo

Though born in Porvoo, south-east from Helsinki, my true, ´adopted´ hometown is Rauma, a city with 38,000 citizens located on the west coast of Finland. Rauma is known for its historical old wooden city centre; lace and the culture related to it; and the special dialect, which, in fact, is more of its own language. Even some Finnish people have difficulties in understanding it! The Rauma 'language' has inherited words, especially Swedish, English and German, due to its seafaring past.

Being developed around a Franciscan monastery, Rauma attained the status of a town in 1442 and is therefore the third oldest town in Finland. The development of Rauma was threatened by a series of fires in the 1500s and 1600s, as well as by illnesses like plague. In the 17th century, a customs fence was erected around the city, and this limited its expansion. Because of this, locals still name the people who move to Rauma from other cities as ´the ones who came through the customs´.

The Old Town of Rauma is one of the four UNESCO world heritage sites in Finland. What makes it unique is the fact that it's the only urban site exemplifying an original Scandinavian wooden town. The citizens are proud of the architecture of the Old Town and it is not only a tourist attraction, but also

Street view of Old Rauma.

an area covering nearly 30 hectares including a market place, shops, cafes, and pubs, as well as privately owned and occupied wooden houses. A 50 m2 flat in Old Town can easily have a price tag of 150,000 euros.

Like many other old cities by the coast, sailing, harbour and ship yards have always been an inseparable part of Rauma. Many high-standard merchant ships, icebreakers and luxury cruise liners sailing worldwide have been built in Rauma. Besides the ship building industry, engineering and the pulp and paper industry are nowadays important sectors in Rauma. While many paper mills are being shut down elsewhere, Rauma has been able to keep its position as one of the world's leading centers for the pulp and paper industries and is even one of the most important manufacturers of magazine paper

The lighthouse island of Kylmäpihlaja.

in Europe. Also, two out of the four nuclear power plants in Finland are located less than 30 km away from Rauma in Olkiluoto.

For me, the beauty of Rauma is in the friendliness of people who are strongly committed to their hometown, in the narrow streets of old Rauma, in the marine atmosphere and through the mix of traditional and industrial lifestyle.

Jaana Isotalo is a Training Specialist in the Nuclear Power Engineering Section.

Faenza, Italy

By Stefano Monti

Faenza, in the heart of Romagna, located 50 km from the Bologna International Airport and 50 km from Ravenna with its mosaics and the sea, is a city of art, culture and good food that is still on a human scale.

The local pottery (*faience*) made Faenza famous worldwide. Its international museum is visited every year by thousands of tourists from every continent. Faenza's art schools have trained many well-known artists around the world, and its numerous workshops produce pieces of style and high class, as well as practical items for everyday use, all still in line with the original tradition and quality.

Piazza del Popolo in Faenza

But Faenza is not only known for pottery, the Milzetti Palace is one of the finest examples of Italian neoclassicism, not to mention the many perfectly preserved mansions around the beautiful *Piazza del Popolo*. The Piazza is surrounded by colonnades, and is distinguished by the cathedral built in the 13th century, the fountain with dragons and rampant lions, the clock tower and the mediaeval town hall.

In late June every year, a horse race for the *Palio del Niballo* takes place, in which the five districts of the city challenge each other to win the coveted banner. The race, which concludes activities that involve the local streets throughout the year, is preceded by games of skill with flags and a parade in medieval costumes that winds through the main streets of the center.

Flag parade in Faenza.

Hospitality, courtesy and good cuisine in the many restaurants and *trattorias* is a worthy setting for this scene.

Stefano Monti is Team Leader for Fast Rector Technology Development in the Nuclear Power Technology Development Section.

Bandung, Indonesia

By Hadid Subki

Bandung is the city where I was born, grew up, studied and started my nuclear career at the **TRIGA Mark II Research Reactor Centre**, which was the first nuclear installation, not only in Indonesia, but also in South East Asia.

The reactor was supplied by General Atomic – USA in 1962 and has been operated by BATAN since then for research and radioisotope production. There are now three research reactors operating in Indonesia.

Bandung is the capital of the West Java province in Indonesia. It is the country's third largest city with a population of 2.7 million. Located 770 meters above sea level and 160 km southeast of Jakarta, Bandung has cooler temperatures than most other Indonesian cities. The city is located amidst green

Tea plantation near Bandung.

and flowering parks and lies in a river basin, surrounded by volcanic mountains.

The Dutch first established tea plantations around the mountains in the 18th century, and a road was constructed to connect the plantation area to the capital. There are many highland villas, exotic hotels, restaurants, cafes and European boutiques in Bandung, hence the city was nicknamed **Parijs van Java** (Dutch for "The Paris of Java").

The northern part of the city is hillier than the rest; the distinguishing 'upside-down boat shape' of the **Tangkuban Perahu Volcano** can be seen from the city, to the north. Long term volcanic activity has created fertile soil suitable for intensive rice, fruit, tea, tobacco and coffee farming.

The main landmark of Bandung is **Gedung Sate**, a neoclassical building mixed with native elements. Once the seat of a Dutch East Indies colonial office, it now serves as the Office of the Governor of the West Java province. In 1955, the first **Asian-African Conference,** also known as the **Bandung Conference,** was held in Bandung and chaired by **President Soekarno**. It was attended by head of states representing 29 countries and colonies from Asia and Africa.

Gedung Sate, main landmark of Bandung.

Hadid Subki is a nuclear engineer in the Nuclear Power Technology Development Section.

Upcoming Events January to April 2013

Date	Title	Location	Contact
23–25 Jan	Meetings of the Technical Working Group on Nuclear Desalination (TWG-ND)	IAEA, Vienna,	I.Khamis@iaea.org
28–29 Jan	Third Meeting of the International Scientific Programme Committee in preparation of the FR13 Conference	IAEA, Vienna	S.Monti@iaea.org
11–14 Feb	Technical Meeting on Topical Issues of Infrastructure Development: Nuclear Power Project Development in Emerging Nuclear Power States	IAEA, Vienna	V.Nkong-Njock@iaea.org
20–22 Feb	Meeting of the Technical Working Group on Life Management of Nuclear Power Plants (TWG-LMNPP)	IAEA, Vienna	K–S.Kang@iaea.org
25–28 Feb	Fourth Workshop for the ICSP on Integral Water Cooled Reactor Designs	Pisa, Italy	J.H.Choi@iaea.org
26–27 Feb	Third Joint GIF - IAEA Workshop on Safety Design Criteria for Sodium-Cooled Fast Reactors	IAEA, Vienna	J.R.Phillips@iaea.org S.Monti@iaea.org
28 Feb – 1 March	7th GIF-INPRO Interface Meeting	IAEA, Vienna	J.R.Phillips@iaea.org
4–7 Mar	International Conference on Fast Reactors and Related Fuel Cycles: Safe Technologies and Sustainable Scenarios (FR13)	Paris, France	S.Monti@iaea.org
4–7 Mar	Workshop on Obsolescence Issues and Digital I&C Modernization Approaches	Buenos Aires, Argentina	J.Eiler@iaea.org
5–7 Mar	Meeting of the Technical Working Group on Gas-Cooled Reactors (TWG-GCR)	IAEA, Vienna	B.M.Tyobeka@iaea.org
12–14 Mar	First Research Coordination Meeting on Prediction of Axial and Radial Creep in HWR Pressure Tubes	IAEA, Vienna	J.H.Choi@iaea.org
13–15 Mar	Technical Meeting on Design review process to support expansion and new NPP programme	IAEA, Vienna	A.Kilic@iaea.org
18–21 Mar	Technical Meeting on Country Nuclear Power Profiles	IAEA, Vienna	J.Mandula@iaea.org
9–10 Apr	Technical Meeting on Existing and Proposed Experimental Facilities for Fast Neutron Systems	IAEA, Vienna	S.Monti@iaea.org
10–12 Apr	Technical Meeting on Liquid Metal Reactor Concepts: Core Design and Structural Materials	IAEA, Vienna	S.Monti@iaea.org
16–18 Apr	First Research Coordination Meeting on Application of CFD Codes for the Design of Advanced WCRs	IAEA, Vienna	M.Harper@iaea.org
21–27 Apr	Independent Engineering Review of I&C Systems (IERICS)	Severodonetsk, Ukraine	J.Eiler@iaea.org
22–26 Apr	Technical Meeting on Becoming a Knowledgeable Customer	IAEA, Vienna	D.Kovacic@iaea.org Y.Troshchenko@iaea.org

Impressum

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