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Nuclear Power Newsletter

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Tianwan Nuclear Power Plant (Photo: Zou Xuxin/CNNC)

IAEA Power Reactor Information System PRIS Turns 40

PRIS, the Power Reactor Information System, has been developed and maintained by the IAEA for four decades. It is a comprehensive database focusing on nuclear power plants worldwide. PRIS contains information on power reactors in operation, under construction or those being decommissioned. The database constitutes an essential source of information that supports analyses of nuclear power development and nuclear power plant performance.

"PRIS covers reactor specification data, such as status, location, operator, owner, suppliers, milestone dates, and technical design characteristics and schematics" explained Jiri Mandula of the Nuclear Power Engineering Section, who is the PRIS Administrator. "The database also provides performance data including energy production, energy loss data, and detailed outage records including cause codes", he added. The electricity production data are complemented also by information on energy provided by nuclear power plants for non-electrical applications such as district heating, process heat supply or desalination. Information about the decommissioning process of shutdown units has also been incorporated in PRIS.

A set of internationally accepted performance indicators has been developed for calculations with PRIS data. The indicators can be used for benchmarking, international comparison or for analyses of nuclear power availability and reliability according to reactor type,

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Message from the Director

The 11th of March was the first anniversary of the tragic accident at the Fukushima Daiichi nuclear power plant in Japan. The IAEA has made considerable efforts to support Japan in restoring normality at the plant and in implementing detailed activities of the IAEA Action Plan on Nuclear Safety, which was approved by the General Conference in September 2011. The Division of Nuclear Power (NENP) has actively participated in all IAEA activities concerning the Fukushima nuclear accident. An International Experts Meeting on Reactor and Spent Fuel Safety took place at IAEA Headquarters from 19 to 21 March, in which some 250 international experts participated. All staff of the NENP Division will do their best to support the successful implementation of the Action Plan.

The first Divisional retreat in 2012 was held on 2–3 March. The main topic was a preliminary discussion on planning the 2014–2015 and the 2016–2017 Programmes of the Division. Sixteen staff members from the Sections and Groups of the Division joined the retreat, including the Section Heads of Nuclear Power Engineering and Nuclear Power Technology Development, and the Group Heads of INPRO and the Integrated Nuclear Infrastructure Group (INIG). Among the issues raised and discussed were the coordination of our work with other international organizations related to the Fukushima nuclear accident, and the coordination with other Departments such as Technical Cooperation and Nuclear Safety and Security to determine how to improve external communications, how to recover public confidence in nuclear power, and others. It was decided to revisit these issues in the next Divisional retreat.

One of the major activities during the last few months was the follow-up Integrated Nuclear Infrastructure Review (INIR) Mission to Jordan, conducted from 17–19 January 2012 upon the request of Jordan. The main purpose was to review the implementation of the Jordan's Action Plan based on the recommendations of the 2009 INIR mission. It was the first Follow-up INIR Mission. The seventh INIR Mission is planned for Belarus from 18–29 June 2012, which will cover both Phase 1 and Phase 2 of the Milestones approach. A pre-INIR mission to Belarus took place in April 2012, to better prepare the upcoming INIR mission in June.

We welcome two new staff members in the Division, Mr John Moore from Canada, and Mr Janos Eiler from Hungary, who both joined the Nuclear Power Engineering Section recently. It has already become a tradition that staff members introduce their home towns. In this issue, Karen Edge introduces Cedar Crest in New Mexico, USA, Alexey Kathukov writes about Tula in the Russian Federation, Tsveti Miliovska presents Sofia, Bulgaria, and Mzubanzi Bismark Tyobeka introduces Pretoria in South Africa.

I wish all readers of this newsletter enjoyable summer days.

Jong Kyun Park
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and country of origin. The analyses can, in turn, be applied to evaluations of the competitiveness of nuclear power compared to other power sources.

History of PRIS

In 1970, the IAEA issued for the first time a questionnaire to collect information about the 63 reactor units that were in operation then in 14 Member States. The information received was used in the first issue of *Operating Experience with Nuclear Power Stations in Member States,* published by the IAEA as document IAEA-127. Since then, this annual publication has been providing comprehensive information on nuclear power reactor performance in Member States. In addition to annual information, the report contains a historical summary of performance during the lifetime of individual reactors and figures illustrating worldwide performance of the nuclear industry.

The questionnaire was the basis for the PRIS database. During the 1970s, the data were collected in paper form using improved questionnaires. In 1981, the IAEA computerized all data collected to date, and PRIS became an IT supported database. Using PRIS data, *Nuclear Power Reactors in the World* was published for the first time in September 1981. This was the beginning of Reference Data Series No. 2 (RDS -2), which has become one of the IAEA's most popular annual publications. It includes 25 tables with a global overview of power reactors.

In 2009, a web-based PRIS-STATISTICS reporting system was developed, making PRIS reports globally available on-line. The user friendly interface allows users to easily generate both global and plant specific reports. Graphs on nuclear energy status, performance and trends can be created by just a few mouse clicks. The system includes also an integrated mapping system.

How to Access PRIS

PRIS is available to both registered users and the general public. For registered PRIS users, the web portal, called PRISWEB (http://prisweb.iaea.org), consists of two applications:

- **Web-Enabled Data Acquisition System (WEDAS)**

  This web based tool is used by PRIS data providers in Member State for inputting specification and operational data on their nuclear power reactors to the database. The data provided is verified and approved by PRIS administrators before it is published for use in PRIS statistics and publications.

- **PRIS Statistics (PRISTA)**

  This web based reporting tool provides a variety of reports on reactor specification and operational data to registered users. PRISTA is a source of information for Member States and the international nuclear industry. PRISTA is dependent on WEDAS for user authentication and authorisation.

Public PRIS website at www.iaea.org/pris.

"As a part of the PRIS anniversary, we launched a new public PRIS website in February 2012. This new gateway to PRIS provides information about the database and associated services, and it provides a series of statistical reports on the world's nuclear power reactors for the general public" said Mr Mandula. The modern design and layout of the public website also includes an overview of related publications and a detailed glossary of terms used in PRIS reports. The navigation is user-friendly and offers easy access to a combination of statistical reports and graphical outputs. The PRIS public website is available at http://www.iaea.org/pris.

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IAEA and FORATOM Expand Cooperation

The longstanding cooperation between the European Atomic Forum (FORATOM) and the IAEA Department of Nuclear Energy has recently been expanded to include the areas of energy planning, human resources management, knowledge management and waste management.

This broadened collaboration was formalized on 20 March 2012 with the signing of a Practical Arrangement between the two organizations, by Jean-Pol Poncelet, Director General of FORATOM and Alexander Bychkov, IAEA Deputy Director General for Nuclear Energy.

FORATOM represents 17 national nuclear associations, which today have almost 800 members from the European nuclear industry. It is therefore a very important partner for the IAEA in the promotion and implementation of its Safety Standards and its Nuclear Energy Series documents. Feedback from the industry, made available through FORATOM, is essential for the continuous improvement of various types of IAEA publications.

The IAEA and FORATOM have a tradition of more than 30 years of close cooperation in the promotion of, and providing guidance on, the application of IAEA Safety Standards related to management systems. This cooperation dates back to 1981 when the Quality Assurance Working Group (QWG) of FORATOM established strong links with the IAEA. Although the IAEA and FORATOM have cooperated in many important areas over the years, the work of the QWA, now better known as the Management System Task Force, has been particularly notable.

This task force has been very active and benefits from the participation of all important nuclear organizations in

Europe, as well as that of many central and eastern European countries as observers. The work of the Task Force, which includes regularly organizing joint IAEA-FORATOM management system workshops, greatly contributed to increasing the visibility of IAEA publications and guides on quality assurance and management systems.

In addition to the upcoming 11th IAEA-FORATOM Management System Workshop in June in Stockholm, Sweden, a technical meeting on stakeholder involvement will be organized in close cooperation with FORATOM, to be held in Vienna on 9–12 October 2012.

Similar activities in the other areas of human resources, knowledge management and waste management are planned for the near future.

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J.P. Poncelet, Director General of FORATOM, and A. Bychkov, IAEA Deputy Director General for Nuclear Energy, signed a Practical Agreement on 20 March 2012.

Nuclear Power Engineering

11th IAEA-FORATOM Management System Workshop

One of the most important vehicles for promoting the application of the IAEA Safety Standards for management systems are the management system workshops, organized every 18 to 24 months. “The workshops have been a success over the years with frequently more than 100 participants” said Jeannot Boogaard, Technical Lead for Management Systems in the Nuclear Power Engineering Section. “In recent years, the workshops were also attended by countries outside Europe. This is an indication that many IAEA Member States appreciate the workshops and their programmes”, Mr Boogaard noted.

The last two workshops focused on practical aspects of the implementation of a process based management system as described in the IAEA Safety Standards on management systems.

In 2009, the 9th Workshop considered approaches to the implementation of an integrated management system as a logical development of an existing management system. In 2010, the 10th workshop looked at helping Member States apply IAEA requirements and guidance on management systems through the sharing of good practices and solutions to commonly encountered challenges and problems.

This year, the 11th management system workshop will be held from 12-14 June in Stockholm, Sweden, with the objective of promoting a sustainable management system, as developed through the IAEA Safety Standards (GS-R-3, GS-G-3.1 and GS-G-3.5) and to provide an international forum for the exchange of experiences, practical examples and case studies.

The programme will include a mix of keynote speeches and interactive working group sessions. It will focus on specific topics relevant to the sustainability of an effective management system:

- Leadership and commitment to safety (day 1);
- Organizational culture (day 2);
- Improvement and sustainability (day 3).

“We want to foster the exchange of practical ideas and strategies, rather than theoretical or abstract concepts, or restating the contents of the IAEA Safety Standards” explained Mr Boogaard.

The sessions will also focus on identifying common difficulties, possible solutions and good practices with regard to establishing, implementing, assessing and continually improving management systems.

More information on the workshop is available at http://www.foratom.org/events/MSTF2012/

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Reviewing Japan’s Comprehensive Safety Assessment

At the request of the Government of Japan, the IAEA reviewed the approach of the Nuclear and Industrial Safety Agency (NISA) to the *Comprehensive Assessments for the Safety of Existing Power Reactor Facilities.*

The IAEA safety review mission was conducted in January 2012 by a team of five IAEA staff from the Department of Nuclear Safety and Security and the Department of Nuclear Energy as well as three international experts. The mission included meetings at the NISA offices in Tokyo and a visit to the Ohi Units 3 and 4 (PWR, 1180 MW(e)). Ohi’s practices provided an example of both how the Comprehensive Safety Assessment was being implemented by an operating organization, and how a NISA review is being conducted.

The scope of the IAEA mission covered the NISA review process of the Comprehensive Assessments and used the IAEA document *A Methodology to Assess the Safety Vulnerabilities of Nuclear Power Plants against Site Specific Extreme Natural Hazards* and the associated IAEA Safety Standards to identify whether NISA’s Comprehensive Safety

Assessment process appropriately considers external hazards, evaluation of safety margins, plant vulnerabilities and severe accident management.

The mission covered four areas:

- Regulatory review and assessment process;
- External hazards and evaluation of safety margins;
- Plant vulnerabilities against station blackout and loss of ultimate heat sink;
- Severe accident management.

IAEA Safety Review Mission in Japan, January 2012.

"The IAEA mission received excellent cooperation from all parties" noted Mr Ness Kilic of the Nuclear Energy Engineering Section. NISA, the Japan Nuclear Safety Organization (JNES), and the Kansai Electric Power Company (KEPCO) provided information. "The mission identified a number of good practices, and also made recommendations and suggestions to enhance the effectiveness of the Comprehensive Safety Assessments", said Mr Kilic.

The final report is available on-line:

http://www.iaea.org/newscenter/focus/actionplan/reports/nisa-mission-report0312.pdf

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Flexible Operation of Nuclear Power Plants

The majority of existing nuclear power plants is optimized to operate at steady full power, known as 'base-load' operation. When nuclear power plants are operated in base-load mode, other energy generating units, such as hydroelectric units, or coal or gas fired plants, operate flexibly to balance electricity generation and demand.

"In several Member States, the *nuclear* units are operated flexibly, and other countries are also considering this option", explained Ness Kilic from the Nuclear Power Engineering Section. To investigate the extent of potential assistance that the IAEA could provide to Member States concerning flexible operations, a group of experts was invited to the IAEA to discuss the challenges of safe, efficient and reliable operations including specific areas of design, economics, controls, reactivity and fuel management, and component ageing.

Although economic reasons and simpler operation make the 'base-load' mode of operation currently preferable, in the future, nuclear power plants will increasingly need to operate in 'flexible' modes, i.e. load following, frequency response, or abrupt changes to output upon requests from grid operators (see figure below). This will be mainly due to one, or a combination of the following factors:

- Large or growing percentage of the nuclear generating capacity;
- Rapid growth in generating capacity of renewables;
- Deregulation of the public electricity supply system;
- Changes to the structure of the electricity supply system and electricity market during the long operating lifetime of a nuclear power plant.

"Therefore, the nuclear energy sources need to adapt to a new energy structure and portfolio and be capable of flexible operation" said Mr Kilic. "They also need to be able to operate flexibly when required".

It was concluded that there is a need for specific guidance to assist countries that are considering flexible operations, either by new construction or conversion of existing plants. Such guidance would include selection criteria, feasibility and decision processes, and operational experience, which is available for the planning, design change, licensing, and operation phases.

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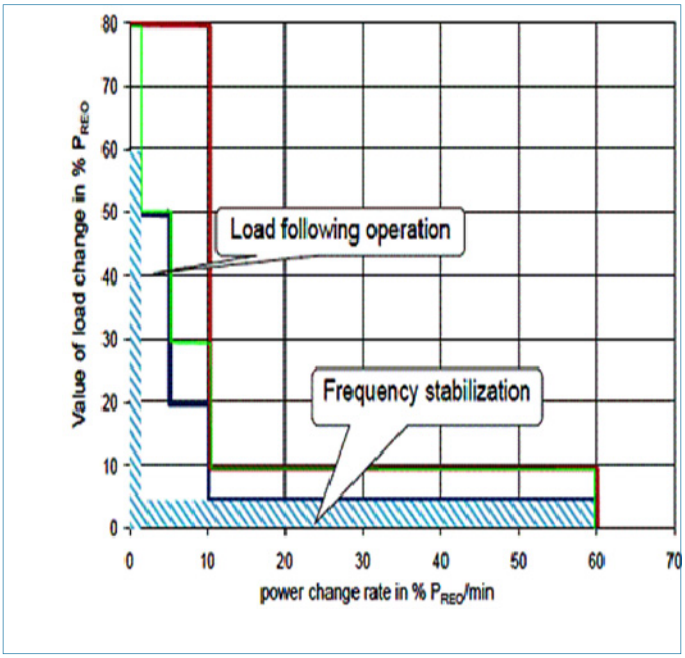
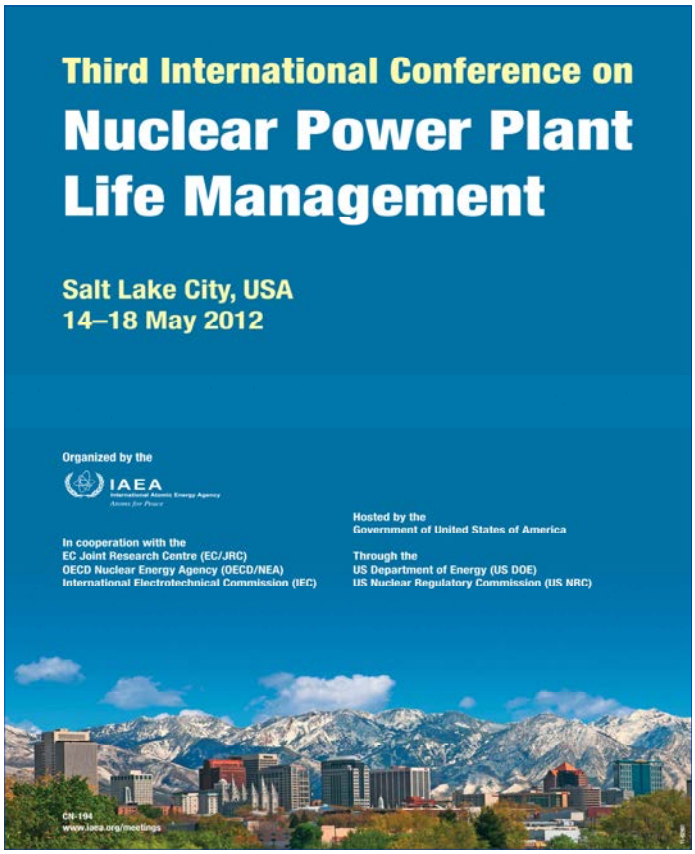


Example of flexible operation ranges (Source: Holger/Salnikova).

Coming Soon ...



Currently 445 (369 GW(e)) nuclear power plants are in operation worldwide. Thereof, 349 units (297 GW(e)) have been in operation for over 20 years. Many nuclear power plants are now engaged in studies to determine the best ways to prolong plant service life. "We see an increasing need for engineering support in operation, maintenance, safety review and plant life management", said Ki-Sig Kang, Technical Head for Plant Life Management and Long Term Operation in the IAEA's Nuclear Power Engineering Section. "Also, education and training in managing issues of long term operation are important", he added.

Plant life management (PLiM) techniques integrate plant ageing and economic planning. These techniques have been used in operating nuclear power plants to maintain a high level of safety, optimize performance and justify long term operation (LTO) beyond the plant design life. In response to the Fukushima nuclear accident, operators have become even more attentive to measures that can go beyond the original design as they prepare nuclear power plants for operation that exceeds their design life.

The IAEA is one of the global focal points and drivers of PLiM for LTO programmes in Member States. Two international conferences have been organized in the past decade. The third PLiM conference will be held from 14–18 May 2012 in Salt Lake City, Utah, USA. Some 350 participants from 28 countries and two international organizations will participate in this conference. The conference programme will include eight keynote speakers, 24 technical sessions, two panel discussion sessions, and a poster session as well as exhibitions on non-destructive examination (NDE), investigation on material degradation, software demonstration forums and digital I&C technology.

"This international conference will be much larger than the first two meetings held in 2002 and 2007. The number of participants has almost doubled since the first PLiM Conference", Mr Kang pointed out. "This is a clear indication of the growing importance of plant life management techniques".

Visit the Conference webpage at:
http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=41982

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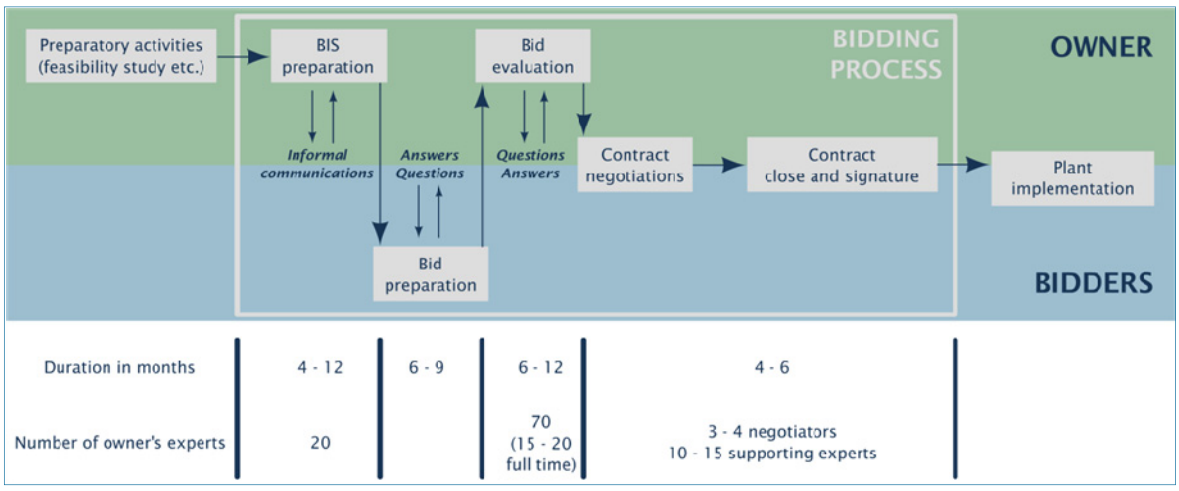
Invitation and Evaluation of Bids for Nuclear Power Plants

The introduction and expansion of nuclear power opens up new challenges for Member States. A new IAEA Nuclear Energy Series report (NG-T-3.9) focuses on how to best organize, guide and realize activities related to the development of bid invitation specifications, technical and economic evaluation of bids and contracting the successful bidder. The report takes into account recent experiences of Member States in the bidding process and includes updated information from other IAEA publications.

An electronic copy of the report is available at: http://www-pub.iaea.org/books/IAEABooks/8690/Invitation-and-Evaluation-of-Bids-for-Nuclear-Power-Plants



Phases, durations and human resource needs for the bidding process for a nuclear power plant.

Upgrading the BIDEVAL Application

Complementary to this new publication, the Nuclear Power Engineering Section is also upgrading the computer program package BIDEVAL-4, used for bid evaluation. This application, originally developed by the IAEA in 1986, is designed to assist Member States in evaluating bids for nuclear power plant projects, based on the IAEA account system. This is a comprehensive accounting system addressing all issues, from a complete nuclear power plant down to individual systems and components.

The upgraded application will have new engineering features and provide users with more flexibility to evaluate the country's participation and local industrial involvement. The update will be a web based application and can be used offline. It is planned to release th new verison of BIDEVAL-4 on the IAEA website in September 2012.

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Fatigue Analysis in Operating Plants

The fatigue mechanism in nuclear power plants can occur in many locations, specifically if the cycle stress is higher than the endurance limit due to chock transients, stratification, fluctuation piping expansion and oscillating pressures. There are key differences between fatigue requirements in the design phase and the operation phase.

However, very few fatigue failures in the hundreds of reactor years of operation accumulated worldwide have occurred to date. For example, fatigue control programmes in Latin America are actually very similar, even though there are large differences in the designs of plants in operation.

This was discussed at an IAEA technical workshop in Rio de Janeiro, Brazil, where experts from Argentina, Brazil, Mexico and invited international experts participated.

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Supporting Nuclear Infrastructure Development

IAEA Annual Workshop on Nuclear Power Infrastructure

The 6th Annual Workshop on Nuclear Power Infrastructure, held at the IAEA on 24–27 January 2012, addressed the needs of Member States that have already started or are considering a new nuclear power programme. Interest in this meeting was considerable, attracting 76 participants from 43 countries and 3 international organizations (EU, WANO and WNA).

Lessons learned: The Fukushima Daiichi nuclear accident and its impact on the development of new nuclear power programmes were on the agenda, as well as lessons learned from the accident, all of which affect public opinion about nuclear energy. One country reported its decision to postpone their nuclear programme. "Those countries with a strong national position on introducing nuclear power, however, are still committed to developing their national nuclear infrastructure" said Mr Masahiro Aoki from the IAEA's Integrated Nuclear Infrastructure Group (INIG), and Scientific Secretary of the meeting. "The factors that contribute to interest in nuclear power in these countries have not changed, such as energy demand, concerns about climate change, volatile fossil fuel prices and security of the energy supply" Mr Aoki explained.

Many countries are also planning to enhance the safety of their nuclear power programmes, based on the lessons learned from the Fukushima accident.

National Position: The development of a national position to introduce nuclear power is one of the key issues in Phase 1 of the IAEA Milestones approach. It was stressed that the

national position must be based on a comprehensive understanding of all issues and long-erm commitments associated with a nuclear power programme, as well as stakeholder involvement. The introduction of nuclear laws or cross-party agreements can contribute to the development of a national position. Participants also shared good practices and reported on difficulties encountered in developing a national decision.

Integrated Nuclear Infrastructure Review Service (INIR): Several countries emphasized the benefits of the IAEA review services, delivered in the form of INIR missions, as it helps them to identify gaps in their infrastructure development. They also acknowledged that INIR missions are not a 'test to be passed', but a learning process for further improvement and are an important aspect of the integrated assistance to newcomer countries that the IAEA offers.

Even countries that have advanced to preparation for construction and operation of the first nuclear power plant need to build capacity and secure appropriately trained people for future positions, as owners/operators as well as in the regulatory body. Vendor countries indicated that they will provide assistance by sharing their experience. "The meeting participants also recognized the role of the IAEA, in particular in assisting newcomers to become knowledgeable customers", said Mr Aoki.

The meeting also addressed an integrated approach for nuclear safety, security and safeguards, and common technology challenges that nuclear power newcomers are facing, e.g. relatively small size of the electrical grid or lack of sufficient coolant near the planned nuclear power station. The workshop was extremely beneficial for sharing information and experiences, not only between embarking and experienced countries, but also among newcomer countries.

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Jordan Receives Follow-up Mission to INIR

In January 2012, Jordan received a follow-up mission to review its action plan, responding to recommendations from the INIR mission conducted in August 2009. A team of international experts and IAEA staff, led by JK Park, Director of the Division of Nuclear Power, reviewed the national action plan. The team noted that progress had been made since 2009, especially in the activities related to the nuclear power plant project. The mission team made several recommendations and suggestions to strengthen the action plan. Because the follow-up mission was not reviewing the infrastructure status, the mission team suggested that Jordan consider inviting a Phase 2 INIR mission in early 2013.

Representatives from several organizations in Jordan, including the Jordan Atomic Energy Commission, the Jordan Nuclear Regulatory Commission, the Ministry of Foreign Affairs, and the Environment Ministry, participated in the discussions.

"This was the first time a follow-up INIR mission has been conducted" stressed Mr Park. "Jordan was also the first country to invite an INIR mission in 2009".

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Progress in Bangladesh's Nuclear Power Programme

Following an INIR mission to Bangladesh last November, relations between Bangladesh and the IAEA were further strengthened when IAEA Deputy Director General for Nuclear Energy Alexander Bychkov visited the country in February. In discussions with high government officials including Mr Architect Yeafesh Osman, Minister of Science and Technology (MOST), Mr Dilip Kumar Basak, Additional Secretary, MOST, and Mr A.S.M. Firoz, Chairman of the Bangladesh Atomic Energy Commission, recent developments in the country's Rooppur nuclear power plant project were addressed.

"I was pleased to hear that the INIR mission team concluded that Bangladesh has achieved notable progress in its nuclear infrastructure development", said Mr Bychkov in an address at the Ministry of Science and Technology in Dhakar, Bangladesh. "But the Agency also learned through this mission — namely that the Milestones approach is flexible and can take into account the national circumstances of the Bangladesh programme. I would like to thank Bangladesh for participating in this INIR and sharing with us your experiences", Mr Bychkov emphasized.

He also briefed the government officials about the *Action Plan on Nuclear Safety* and pointed out that the plan "will strengthen the global nuclear safety framework and requires the commitment of all stakeholders. This is particularly important for nuclear safety in all States that already have or that are embarking on a nuclear power programme, such as Bangladesh".

A visit to the Atomic Energy Research Establishment (AERE), the major nuclear research institute in Bangladesh, was also on the agenda for Mr Bychkov's visit. AERE includes various facilities such as a TRIGA Mk-II research reactor, a TANDEM accelerator, a Tc-99 kit production facility, and a radioactive waste storage facility. AERE has also established a new training facility and a training system to develop the required human resources for the new nuclear power project.

Making effective use of the IAEA technical cooperation programme, the training system is based on a 'train the trainers

TRIGA Research Reactor at AERE, Bangladesh..

approach', i.e. experts trained in IAEA training courses will then transfer the acquired skills and knowledge to their colleagues in Bangladesh.

Appreciating IAEA assistance given to date in building their new nuclear power programme, Bangladesh has requested a so-called 'soft coordination meeting' for the Rooppur nuclear power plant project.

"The concept of soft coordination has been developed to coordinate different sources of international assistance, for example, IAEA technical cooperation, government-to-government bilateral agreements, international consultants and others", explained Ms Anne Starz, Group Leader of INIG. "The Agency can play a role in facilitating exchange of information and coordination while respecting the bilateral or commercial relationships among the parties", she added.

At the beginning, soft coordination will include human resource development, stakeholder involvement, management/ project management, electrical grid, regulatory infrastructure and financing. Later stages may expand to include additional partners.

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Enhancing the Environmental Component in New Nuclear Power Programmes

Environmental protection is an important aspect in deploying new nuclear power programmes. Environmental issues are often directly related to public perception and acceptance of these programmes. As national practices and knowledge in tackling environmental issues may vary greatly, INIG organized a Technical Meeting on Environmental Issues in New Nuclear Power Programmes, held at the IAEA from 20–23 March 2012.

Thirty representatives from 20 Member States discussed the current environmental issues they face in their nuclear power programmes, their experiences in overcoming them and future challenges that need to be addressed. "Newcomer countries are showing a strong interest in ensuring environmentally sound nuclear power deployment in their respective countries" noted Anne Starz, Group Leader of INIG. "But we also see much support from experienced nuclear countries for this topic", she added.

Twenty Member States were represented at the Technical Meeting on Environmental Issues in New Nuclear Power Programmes.

The meeting also discussed, and commented on, a planned IAEA report on environmental issues in nuclear power programmes, drafted by a group of external experts. The objective is to harmonize the processes for environmental protection in Member States. To achieve this, the report will acknowledge good environmental practices and also address issues such as stakeholder involvement and contracting for nuclear power plants.

"In contrast to safety, newcomer Member States have so far not been offered an insight into the environmental aspects of nuclear power", observed a meeting participant. Thus the participants recommended that the IAEA organizes similar meetings on environmental regulations, environmental monitoring and preparation of environmental impact assessments for nuclear power plants.

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

Establishment of the INPRO Group within the Division of Nuclear Power

The IAEA Director General, Mr Yukiya Amano, has approved the formal establishment of the INPRO Group in the Division of Nuclear Power, Department of Nuclear Energy.

This gives the INPRO Group its own administrative identity, similar to the INIG Group and the two Sections in the Division of Nuclear Power.

INPRO was created in 2000 following a resolution of the 44th Meeting of the IAEA General conference. While in 2001 the project counted only ten INPRO Members, by 2012 membership in INPRO has grown to 35 Member States and the European Commission. Since its launch, the INPRO Group has been an informal but recognized entity within the Nuclear Power Technology Development Section.

The formal establishment will facilitate the management of resources and at the same time improve the visibility of the activities, as well as improve the efficiency and effectiveness of the INPRO Group, which now includes five established posts as well as cost-free experts from INPRO Members.

For more information on INPRO go to www.iaea.org/INPRO

Sharing Views on Nuclear Innovations

Safety, proliferation resistance, physical protection and economics of innovative nuclear reactors will continue to be key areas of cooperation between the IAEA/INPRO and the Generation IV International Forum (GIF). This was discussed by some 50 experts of both organizations, who attended the **6th GIF-INPRO/IAEA Interface Meeting** at the IAEA on 6–7 March 2012.

"In order to sustain global energy supplies, the necessity of nuclear technology and its corresponding development will certainly increase" highlighted GIF Chairman Yukata Sagayama. "INPRO and GIF are multilateral international initiatives which focus mainly on R&D and review the next generation of safe and more efficient reactors. It is very meaningful for both organizations to exchange information and cooperate, and I would like to promote further cooperation in the future", Mr Sagayama added.

"Advanced technologies and the closing of the fuel cycle through a transition from thermal to fast reactors will remain a high priority for the IAEA Nuclear Energy Department", noted Alexander Bychkov, IAEA Deputy Director General for Nuclear Energy, who is also the INPRO Project Manager. He stressed the relevance of INPRO activities related to the review of innovative reactor concepts for prevention of severe accidents and mitigation measures, and to the closing of the nuclear fuel cycle.

GIF Progress: Generation IV nuclear energy systems are future, next-generation technologies that will compete in all markets with the most cost effective technologies expected to be available over the next three decades.

GIF has made significant progress in the development of the six reactor systems selected for further study: sodium cooled fast reactor (SFR), gas cooled FR, lead cooled FR, molten salt reactor, supercritical water cooled reactor (SCWR) and very high temperature reactor (VHTR).

Collaborative activities related to the SFR concept focus on the areas of advanced fuels, transmutation of minor actinides, innovative energy conversion systems, safety and operation. One new activity addresses the integration and assessment of the R&D work carried out so far. Key R&D activities on the VHTR include fuel and materials development, high temperature process-heat technologies for hydrogen production, code validation experiments, and others.

Based on lessons learned from the Fukushima Daiichi nuclear accident, GIF developed an Integrated Safety Assessment Methodology (ISAM). Although ISAM is mainly based on a probabilistic safety assessment (PSA), it is useful to apply the methodology before the assessment. ISAM covers the entire design life cycle of a nuclear power plant, i.e. preconcept, concept, final design, licensing and operation. The method guides the design process, thus ensuring that safety requirements will be fulfilled, and it helps identify areas for additional research. GIF is also focusing on developing safety design criteria for SFRs.

6th Interface Meeting: These developments were presented at the recent GIF-INPRO/IAEA Interface Meeting. The INPRO Nuclear Energy System Assessment (NESA) is complementary to the assessments performed by GIF. The INPRO approach to a long-range nuclear energy strategy, and the activities on evaluating collaborative architectures to achieve globally sustainable nuclear energy systems, help shape the implementation of the GIF systems in the future.

INPRO informed GIF representatives on the progress made in these areas. Experts from the IAEA Department of Nuclear Safety and Security introduced the safety assessment implemented by the IAEA, which takes into account lessons learned from the Fukushima nuclear accident, as well as the potential application of the safety assessment to innovative reactor concepts.

"It is worth noticing that a number of activities recently launched by GIF, IAEA/INPRO and the European Commission are focused on the evaluation of the safety approach and safety features of the next generation nuclear systems", said

Opening of the 6th GIF-INPRO/IAEA Interface Meeting by Y. Sagayama, GIF Chairman (second from right), and A. Bychkov, IAEA Deputy Director General for Nuclear Energy.

Stefano Monti of the IAEA Nuclear Technology Development Section, which co-organized the meeting. To facilitate comparing the safety approaches, developing synergies and optimizing the highly qualified competences in this field, the meeting participants agreed to share the outcomes of these activities.

In the area of proliferation resistance, GIF has developed a methodology for proliferation resistance and physical protection (PR&PP). INPRO's new Collaborative Project on a Proliferation Resistance and Safeguardability Assessment (PROSA) will develop a coordinated set of GIF/INPRO tools to identify the interface of the proliferation resistance and safeguards assessment tools at the state, nuclear facility, and nuclear energy system level, and evaluate its usefulness in a reference case study (see article p. 11).

"The goal of the new coordinated set of proliferation resistance and safeguards assessment tools from both the GIF and INPRO methodologies is to make the process of proliferation risk assessment and the results from this type of study more useful to the Member States and more easily understood by the users", said Mr Bychkov.

Taking into account the schedule of GIF activities on safety design criteria for GEN IV SFR, the next interface meeting will be combined with the joint workshop on safety aspects

related to SFR and held at the IAEA at the end of February 2013.

All presentations of the 6th GIF-INPRO/IAEA Interface Meeting are available at http://www.iaea.org/INPRO/cooperation/6th_GIF_Meeting/index.html

Contact: Randy Beatty, INPRO Group; R.Beatty@iaea.org
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INPRO Collaborative Project PROSA Launched

Understanding the peaceful use of a nuclear energy system is crucial for the safe and responsible use of nuclear power. Therefore, proliferation resistant systems must be designed that especially make any diversion or undeclared production of nuclear material or misuse of nuclear technology by States difficult and detectable. They must also enable the IAEA to meet its safeguards goals effectively and efficiently.

"In the INPRO Methodology, proliferation resistance is one of the seven areas used in assessing whether a nuclear energy system is sustainable" explains Randy Beatty, INPRO Group Leader. Similarly, experts of GIF developed an evaluation methodology for proliferation resistance and physical protection of Generation IV nuclear energy systems.

A new INPRO Collaborative Project on 'Proliferation Resistance and Safeguardability Assessment Tools' (PROSA) is now developing a coordinated set of such tools from both the GIF and INPRO methodologies. The two year project benefits from close cooperation between INPRO and the IAEA Department of Safeguards. Experts from Germany, Italy, Japan, the Republic of Korea, Romania and the USA met at the IAEA on 1–3 February 2012 to launch the PROSA project and prepare terms of reference including timeline, deliverables, milestones and contributions by participants. Other Member States who will participate or follow the project as observers are Canada, France, the Russian Federation, the EC's Joint Research Centre and the EU Directorate of Safeguards.

"International experts who are participating in the PROSA project are also involved in the GIF working group on proliferation resistance and physical protection", says Eckhard Haas, consultant to the Department of Safeguards (SG) and INPRO, who is one the Scientific Secretaries of the project.

PROSA project meeting, IAEA, 1–3 February 2012.

"This ensures a two-way information flow and a good cooperation between INPRO and GIF in developing the tools", he added.

"The goal is to make the assessment process and the results more easily understood by the users", explained Yusuke Kuno, Deputy Director and Prime Scientist at the Japan Atomic Energy Agency (JAEA), who chaired the meeting. This will include analyses at the different levels, i.e. State, nuclear energy system and nuclear facility levels, and adjusting the depth of the analysis according to the information needs of different users. "We also want to demonstrate the value of a refined assessment methodology and make recommendations for a correspondingly refined INPRO manual in the area of proliferation resistance", Mr Kuno stated.

PROSA follows PRADA

The PROSA Project is a follow-up activity to the INPRO Collaborative Project on Proliferation Resistance: Acquisition/Diversion Pathway Analysis (PRADA) which was concluded at the end of 2010. PRADA's objective was to provide guidance on enhancing proliferation resistance of innovative nuclear energy systems and contribute to further developing and strengthening the assessment area of proliferation resistance in the INPRO Methodology. PRADA's conclusions were:

1. The robustness of barriers is not a function of the number of barriers or of their individual characteristics but is an integrated function of these, and is measured by determining whether the safeguards goals can be met.

2. The detailed application of the GIF pathway concept to identify and analyze acquisition/diversion pathways for nuclear material demonstrates the feasibility of merging the INPRO and GIF methodologies to form a holistic approach.

Mr Hong-Lae Chang of the Korea Atomic Energy Research Institute (KAERI) had taken the lead in the PRADA project and agreed to continue in that role in PROSA.

INPRO Methodology

In the INPRO methodology, the basic principles associated with proliferation resistance require that intrinsic features and extrinsic measures be implemented throughout the full life cycle of the nuclear energy system, and that they be optimized, by design and engineering, to provide cost effective proliferation resistance. The methodology assumes that international safeguards is an important extrinsic measure. The attractiveness of nuclear materials and technology for diversion to a nuclear weapons programme should be low, and the diversion of nuclear material difficult and detectable.

"I believe the PROSA project will simplify the assessment for proliferation and safeguardability, as well as make the results more easily understood" said James Sprinkle, IAEA Senior Safeguards Analyst and also a Scientific Secretary of the project. "This will be especially important for any newcomer states undertaking an assessment."

The next PROSA meeting is planned for June 5–7, 2012 in Vienna to review the draft of PROSA's first technical document.

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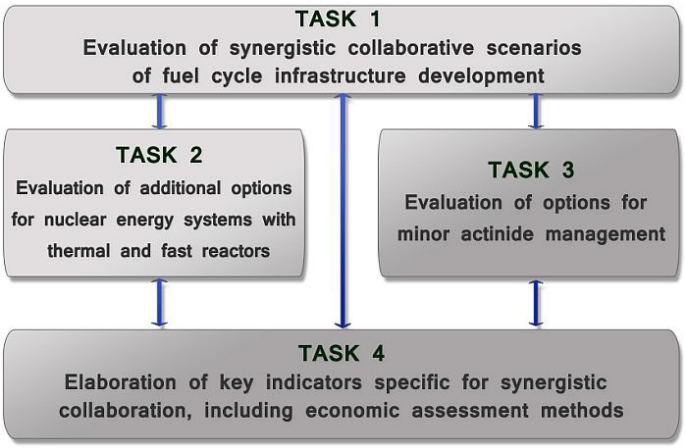
Progress in INPRO Collaborative Project SYNERGIES

A technical meeting, to be held at the IAEA on 4–8 June 2012, will cover the individual tasks of the INPRO Collaborative Project SYNERGIES (Synergistic Nuclear Energy Regional Group Interactions Evaluated for Sustainability). In preparation of this meeting, leadership and participation roles in the SYNERGIES tasks have already been confirmed.



Task 1 objectives are the exploration of technical options and strategies for fresh fuel supply, spent fuel and HLW management, to identify advantages and challenges in the near, medium and longer term; and examination of various scenarios for sharing of facilities and services, and identification of time frames for required infrastructure introduction and expansion, in different stages of the nuclear fuel cycle, from mining to final disposal.

France has taken leadership for Task 1, and Canada, China, India, Indonesia, Romania, the Russian Federation, Spain and Ukraine have confirmed their participation. Belgium and the USA will be the observers in this task.

Task 2 has the objective to carry out investigations of possible synergies among such additional, not yet addressed technology options, as well as those already considered.

The Russian Federation has confirmed leadership for Task 2, with China, India and Ukraine as the participants, while Belgium, Romania, Spain and the USA will participate as observers.

Belgium has confirmed leadership for **Task 3**, which will examine how nuclear energy systems (including reactors and nuclear fuel cycles) could take advantage of the emerging dedicated transmutation systems or purposeful MA applications, in the creation of a synergistic sustainable architecture.

France, India, Spain and the Russian Federation will participate in this task, while China, the EC and the USA will be observers.

Finally, India will take the lead *to develop scenario assessment methods and indicators for all other tasks.* Canada, India, the Russian Federation and Romania will support India's effort through participation in this task, while Belgium, China, the European Commission, Ukraine and the USA will be the observers.

New participants are expected to join the task teams at the forthcoming SYNERGIES technical meeting in June. To facilitate communication at the meeting, common templates for the presentations of the specific task proposals and expressions of interest were developed, with input from all interested experts in Member States.

In support of the SYNERGIES objective, i.e. to examine drivers and impediments for collaboration among countries on the way to sustainable nuclear energy systems, a questionnaire was developed to identify the perceived importance of collaboration among countries on issues that need to be addressed while in transition to sustainable nuclear energy systems. The questionnaire was tested on a group of seven respondents from China, India, Romania, the Russian Federation, Spain and the USA. Collaboration in final disposal of waste scored highest in all terms, well above collaboration related to all other issues (see Figure below).

The plan is to continue this survey with a larger number of respondents at the Workshop on Drivers and Impediments for Regional Cooperation on the Way to Sustainable Nuclear Energy Systems. Currently, the Workshop is planned for the week of 30 July 2012, subject to confirmation of funding.

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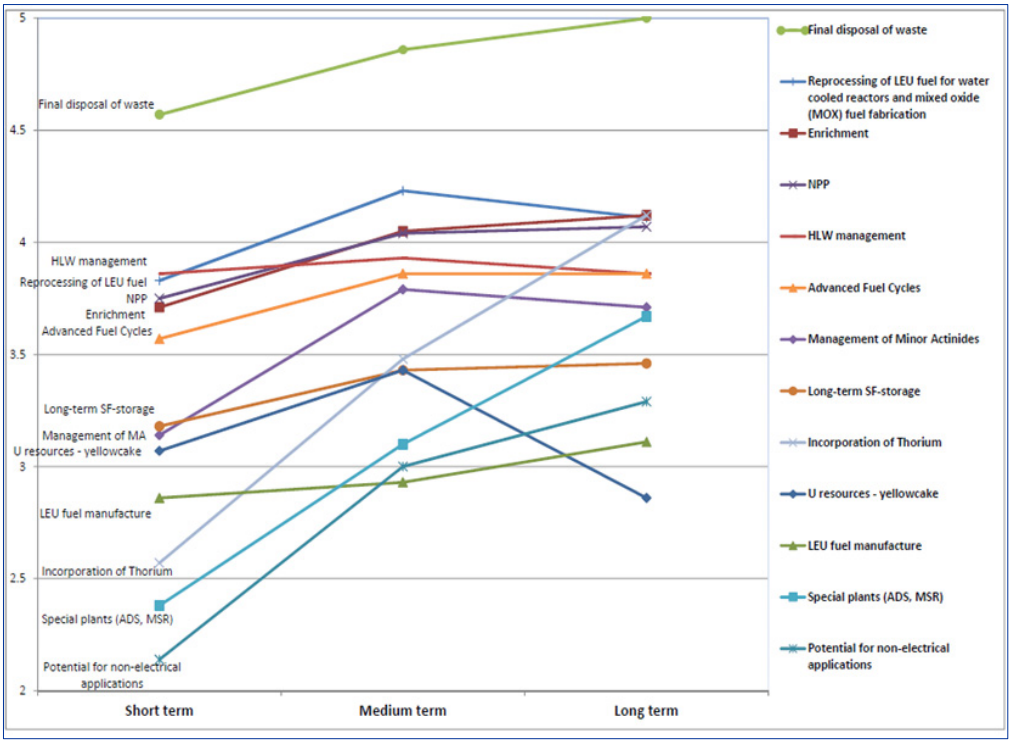

Graphical interpretation of questionnaire responses.

Survey of National Long-Range Nuclear Energy Strategies

INPRO is undertaking a 'Survey of Existing National Long-Range Nuclear Energy Strategies' as part of its activities in the INPRO Action Plan for 2012–2013. The results of the survey will serve as reference material for Member States developing such long term strategies. The survey will be descriptive, not comparative, and will provide an inventory of existing nuclear energy strategies. Documents and information that are publicly available from Member States with existing nuclear energy programmes will be used as a basis.

"The idea is to allow Member States to see how other countries have formulated their strategies for long-range nuclear energy development", said Kamran Qureshi of the INPRO Group, who is the Scientific Secretary for the project. "We will be extracting certain information from these documents, including the time frames covered by existing nuclear energy strategies, the level of depth and details of a strategy, how a strategy was generated and approved, how often it is updated and the relationship with national plans for a country's sustainable development", Mr Qureshi explained.

To start the survey project and benefit from recommendations and advice of experts in INPRO Member States, a consultants meeting was convened on 22–23 March 2012 at the IAEA. Six participants from Algeria, Chile, Indonesia, Republic of Korea, Vietnam and the USA attended the meeting, chaired by Mark Holt from the Congressional Research Service of the US Library of Congress.

The participants reviewed the first set of materials from 14 countries compiled by the IAEA, and recommended to enlarge the scope of the study by including strategies of additional Member States with existing nuclear power programmes. It was proposed to include case studies, i.e. 'success stories' that would show how countries with existing nuclear energy strategies had formulated them, faced any challenges and set priorities. Finally, the participants discussed and made recommendations on a suitable way to structure and present the survey results. They also prepared the draft table of contents for an IAEA publication, which will document the survey results.

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NESA Training Course for Students

As part of the IAEA's capacity building efforts in Member States, a training course for students in technical and nuclear universities has been developed on applying the INPRO Methodology in a nuclear energy systems assessment (NESA). The training course and accompanying learning resources will contribute to creating a better understanding among the younger generation of nuclear specialists of the holistic approach the INPRO Methodology offers and also highlight the importance of a sustainable nuclear energy supply in the 21st century.

Armenia, Belarus, Kazakhstan, the Russian Federation and Ukraine are participating in this activity. At a consultants meeting, held at the IAEA on 15–17 February 2012, participants from the Russian Federation and Armenia presented their national experiences in preparing and testing the training course at national technical and nuclear universities. "In 2011, the training course was delivered in the Russian Federation to students in their junior and senior years at the Obninsk Technical University for Nuclear Power Engineering, and the Moscow Engineering Physics Institute (MEPhI)", said Yuri Busurin of the INPRO Group, who is leading this project.

The lectures developed by the INPRO Group are a good basis for the training course, and several additions and updates were suggested. The participants considered it essential and useful to prepare a textbook for university students that would cover international issues related to an integrated assessment of a nuclear energy system and its sustainability.

Similar to the INPRO manuals that document the INPRO Methodology (IAEA-TECDOC-1575), the proposed textbook would cover the holistic INPRO approach that requires considering the complete nuclear energy system, comprised of reactors and front and back end fuel cycle facilities over the entire life cycle of a facility, from 'cradle to grave', and addressing all seven INPRO areas including economics, institutional measures (infrastructure), waste management, proliferation resistance, physical protection, environment (impact of stressors and availability of resources), and safety.

Contact: Yuri Busurin, INPRO Group; Y.Busurin@iaea.org

Students from the Obninsk Technical University for Nuclear Power Engineering, Russian Federation, attend a lecture on the INPRO Methodology.

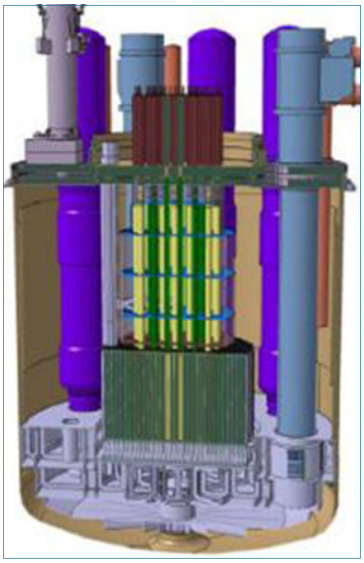
Nuclear Power Technology Development

Fast Reactor Development

Different aspects of fast reactor development were addressed in two technical meetings, held back-to-back at the IAEA from 27 February to 2 March 2012. The meeting on 'Innovative Fast Reactor Designs with Enhanced Negative Reactivity Feedback Features' focused on the design of innovative cores with improved safety characteristics, which represents one of the main challenges for the next generation of fast reactors.

"The design of reactor cores is of paramount importance for preventing meltdown accidents" explained Stefano Monti of the Nuclear Power Technology Development Section, and Scientific Secretary of the meeting. "This design is characterized by intrinsic safety features, for example negative reactivity feedbacks, and complementary passive devices that are simply based on natural phenomena", he added.

Representatives from eight countries discussed the safety characteristics and performance of various core design options that are being developed in national and international programmes on Generation IV fast reactor concepts. On-going R&D activities in the area of core design and advanced simulation tools and methods for coupled neutronic-thermohydraulic-thermomechanic analysis were also presented. "Although there are differences in design goals and in technical solutions, an important outcome of the meeting was that we identified common R&D needs and design approaches", said Mr Monti.



French sodium-cooled demonstration FR ASTRID.

The second technical meeting entitled 'Identifying Fast Neutron Systems Development Gaps', recognized technological gaps between existing and new generation fast reactors. IAEA Coordinated Research Programmes will carry out R&D activities to close these gaps.

Participants from eight Member States with an active programme on fast neutron systems (both critical and subcritical) discussed the status and new trends in fast reactor technology, and presented results of studies and on-going R&D activities in the field.

"The experts identified common needs in many areas" explained Mr Monti. "These include, for example, safety design approach, experimental testing, in-service inspection, innovative materials, instrumentation, and verification, validation and qualification of simulation codes and methods that will be used in fast reactor design and analysis".

Contact: Stefano Monti, NPTDS; S.Monti@iaea.org

Impact of the Fukushima Accident on Fast Reactor Designs

What are the implications of the accident at the Fukushima Daiichi nuclear power station on current and future fast reactor designs?

This question was at the center of an IAEA technical meeting in which 25 experts from six countries and the EC focused on current and future fast reactor designs and operation. They also reviewed the safety principles and characteristics of these nuclear systems, especially in relation to extreme natural events that could potentially lead to severe accidents.

Experts from several countries participated in the Technical Meeting on the Impact of the Fukushima Event on Current and Future Fast Reactor Designs, hosted by HZDR, Germany in March 2012.

Even though these analyses are still in progress, the experts recognized that several issues raised by the Fukushima accident – such as identifying a combination of hazards, defining margin to cliff edge effects, and others – are technologically neutral and could be tackled through international initiatives.

The participants also identified areas of common interest to be investigated by IAEA Coordinated Research Projects, and recognized the role of the IAEA in favoring the harmonization of the FR safety approach and providing recommendations and guidance to achieve the highest levels of safety, in particular concerning innovative concepts that are being developed in different Member States.

The technical meeting on the I*mpact of the Fukushima Event on Current and Future Fast Reactor Designs* was held in Dresden, Germany, from 19–23 March 2012. The event was hosted by the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) and organized by the IAEA Nuclear Power Technology Development Section.

Contact: Stefano Monti, NPTDS; S.Monti@iaea.org

Events on Fast Reactors: April – June 2012

- **Fourth Research Coordination Meeting of the CRP on 'Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the MONJU Reactor Vessel'**, Tsuruga, Japan, 16–20 April 2012.
- **Workshop on 'Prevention and Mitigation of Severe Accidents in Sodium-Cooled Fast Reactors'**, organized by the Japan Atomic Energy Agency (JAEA) in cooperation with the IAEA, Fukui, Japan, 11–13 June 2012. The theme of the workshop is '*Safety approaches to prevent and mitigate severe accidents in SFRs and specific countermeasures*'.
- **Launch of a new Coordinated Research Project** (CRP) addressing the **Shutdown Heat Removal Tests** performed at the US Experimental Breeder Reactor-II (EBR-II) within the framework of the US Integral Fast Reactor (IFR) development and demonstration programme. The first Research Coordination Meeting of the EBR-II CRP will be held at Argonne National Laboratory, Argonne, IL, USA, on 18–19 June 2012.
- **Annual Meeting of the IAEA Technical Working Group on Fast Reactors,** hosted by the Argonne National Laboratory, Argonne, IL, USA, 20– 22 June 2012.

Using SMRs in Hybrid Energy Systems

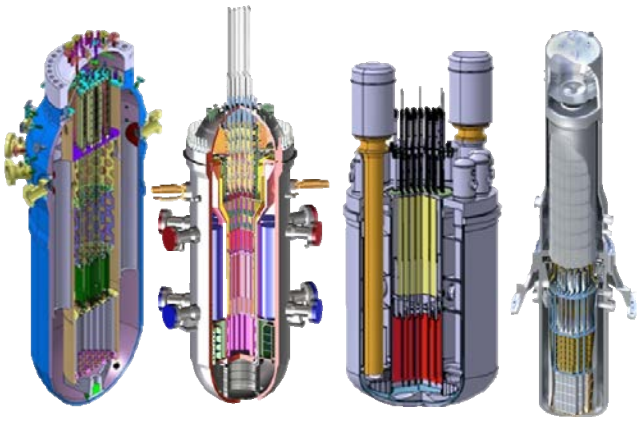
A small or medium-sized reactor (SMR) can provide a flexible base load supply for electricity production and non-electric nuclear applications in combination with renewable energy sources. This can create synergies among clean energy options and address concerns about climate change, price volatility of energy and the variability of renewable energy sources. The advantages of renewables and the stability of nuclear energy together would enhance the security of energy supply.

The IAEA discusses the benefits and the prerequisites of these hybrid systems, explores the potential and preparedness of Member States to deploy them and looks at the possibility of several SMR designs to play such a stabilizing role in mitigating the variability of renewables.

Solar energy, a renewable source of energy (Photo: Nellis Solar Power Plant, USA).

In collaboration with the European Commission's Joint Research Centre (EC/JRC), the IAEA Nuclear Power Technology Development Section is preparing a publication entitled *Options to Enhance Energy Supply Security using Energy Systems based on SMRs: Utilizing Small and Medium-Sized Reactors in Hybrid Energy Systems with Renewable Energy Sources.*

Two meetings in late 2011 and in March 2012 discussed the potential future deployment of such energy systems with technology holders and users and nuclear newcomers. During the March meeting, a comprehensive document was drafted, in which the IAEA will combine the techno-economic research on energy utilization carried out by the EC/JRC with the implementation of conventional energy policies in various newcomer countries. "We should recognize the importance of SMRs in satisfying the need for clean optimum-energy-mix in synergy with other energy resources, and its potential for non-electric applications" said Mr Thomas Koshy, Section Head of the Nuclear Power Technology Development Section.



Examples of SMR design for near term deployment.

"The message is that you can get energy without having to import it, while increasing the share of renewables and making the most of non-electric applications" explained Mr. David Shropshire from EC/JRC.

The scope of the document includes the viability of integrating SMRs and renewable energy; technical aspects of energy storage in hybrid schemes, the use of SMRs for non-electricity applications, energy policy in newcomer Member States focusing on the utilization scheme of renewable energy resources, newcomer countries' requirements and interest in SMRs; and current status of SMR technology developments. It is expected that the publication will be available to Member States in the fall of 2012.

"There is an increasing interest in SMRs since they have also been recognized as suitable for process heat production, desalination, hydrogen generation and many other advanced applications. In response to this trend, it is necessary to launch an international project to facilitate and compile studies on hybrid energy systems based on SMRs", noted Rayman Sollychin of the Division of Nuclear Fuel Cycle and Waste Technology. "We need cross-cutting collaboration in the Agency to achieve this goal".

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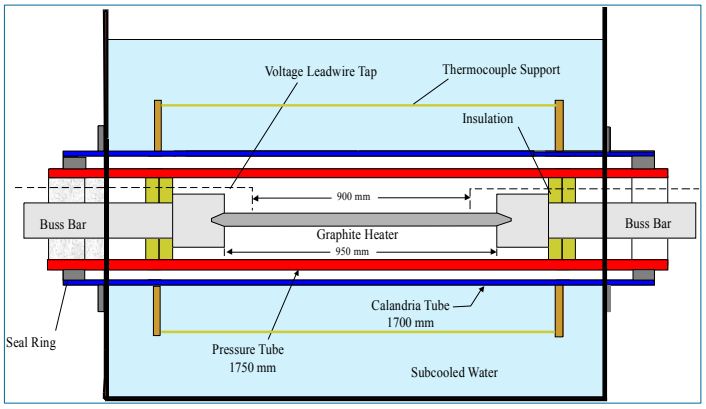
New IAEA ICSP on HWR Moderator Subcooling Requirements

The IAEA is organizing an 'International Collaborative Standard Problem' (ICSP) to facilitate the development and validation of computer codes, for design and safety analysis of nuclear power plants. An ICSP provides a framework for collaboration between Member States to achieve common objectives. The implementation of the ICSP usually includes an experiment to investigate interesting phenomena and a subsequent simulation of the experiment with computer codes.

The IAEA has prepared and distributed a new ICSP proposal on 'HWR Moderator Subcooling Requirements to Demonstrate Backup Heat Sink Capabilities of Moderator during Accidents' and invites the participation of interested institutes.

The purpose of this IAEA ICSP is to provide contact boiling experimental data to assess the subcooling requirements for a heated pressure tube, plastically deforming when coming into contact with the calandria tube during a postulated large break loss of coolant accident condition. The data can be used to assess safety analysis computer codes simulating the following phenomena:

- Radiation heat transfer to the pressure tube,
- Pressure tube deformation or failure,
- Pressure tube to Calandria tube heat transfer,
- Calandria tube to moderator heat transfer,
- Calandria tube deformation or failure.



Experimental apparatus for IAEA ICSP test.

Atomic Energy of Canada Ltd (AECL) has agreed to host this ICSP. Participants should have developed an analysis tool to investigate the above phenomena to be examined in the experiment. The ICSP proposal and participation form are available at http://www.iaea.org/NuclearPower/WCR/ICSP-HWR-Moderator.html

Deadline for submission of the participation form is 15th July 2012.

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Nuclear Power Publications

Recently Published

- **Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: Steam Generators** (IAEA-TECDOC-1668)
- **Construction Technologies for Nuclear Power Plants** (NP-T-2.5)
- **Core Knowledge of Instrumentation and Control Systems in Nuclear Power Plants** (NP-T-3.12)
- **Fast Reactors and Related Fuel Cycles: Challenges and Opportunities (FR09)** Proceedings of an International Conference held in Kyoto, Japan, 7-11 December 2009 (Proceedings Series)
- **Integrated Nuclear Infrastructure Review Mission – Rev 1** (INIR-Rev 1)
- **Invitation and Evaluation of Bids for Nuclear Power Plants** (NG-T-3.9)

Coming Soon…

- **Advances in High Temperature Gas Cooled Reactor Fuel Technology** (IAEA-TECDOC-1674)
- **Advances in Nuclear Power Process Heat Applications** (IAEA-TECDOC-1682)
- **Assessing and Managing Cable Ageing in Nuclear Power Plants** (NP-T-3.6)
- **Electric Grid Reliability and Interface with Nuclear Power Plants** (NG-T-3.8)
- **Management System Standards:** Comparison between IAEA GS-R-3 and ASME NQA-1-2008 and NQA-1a-2009 Addenda (Safety Reports Series No. 70)
- **Management System Standards:** Comparison between IAEA GS-R-3 and ISO 9001: 2008 (Safety Reports Series No. 69)
- **Natural Circulation Phenomena and Modelling for Advanced Water Cooled Reactors** (IAEA-TECDOC-1677)
- **Project Management in Nuclear Power Plant Construction: Guidelines and Experiences** (NP-T-2.7)
- **Role of Thorium to Supplement Fuel Cycles of Future Nuclear Energy Systems** (NF-T-2.4)

Inside the Division of Nuclear Power

New on the Team

Janos Eiler, Nuclear Power Engineer, Nuclear Power Engineering Section

Janos Eiler is responsible for instrumentation and control (I&C) and electrical engineering issues in NPES. Before joining the IAEA, he worked for most of his career at the Paks Nuclear Power Plant, Hungary, where he was responsible for the operation, maintenance, modernization and replacement of the plant's I&C systems. In 2011, after the Fukushima event, he was the coordinating project manager of the Paks stress test. He was also an I&C design engineer at Arizona Public Service, USA. He holds a Master and PhD degree in electrical engineering from the Technical University of Budapest, Hungary.

John Henry Moore, Nuclear Engineer, Nuclear Power Engineering Section

John Henry Moore is responsible for assisting Member States in design, advanced building technologies, quality control and management programmes for new nuclear power plants, and maintenance and repair programmes for buildings and civil structures for operating nuclear power plants. Prior to joining the IAEA, he worked for 27 years with Ontario Power Generation in Canada at the Pickering and Darlington Nuclear Power Plants as systems engineer, commissioning engineer, design manager and project manager. He has a BASc in Electrical Engineering from the University of Toronto, and an MBA from the Schulich School of Business, Canada, and is a Licensed Professional Engineer.

My Hometown

Pretoria, the Jacaranda City

By Bismark Tyobeka

I live in Centurion, a suburb of Pretoria, South Africa. Known as the *Jacaranda City* for all the purple blossom bedecked trees which line its thoroughfares, Pretoria is a lovely, quiet city. With a population that exceeds a million people, Pretoria is one of three capitals of South Africa. It is the executive seat of government, while Cape Town is the legislative seat and Johannesburg is South Africa's economic capital.

The city centre is laid out in typical city fashion on a grid with wide roads, making getting around fairly simple. Here you will find many significant old buildings and some fascinating museums. The Transvaal Museum has wonderful natural history displays and is the home of Mrs Ples, the australopithecine fossil found at Sterkfontein in the 'cradle of humankind'. Also worth visiting are the Cultural History Museum and the Smuts Museum.

Jacaranda trees in Pretoria, South Africa.

When visiting the city, it is practically mandatory to see the Pretoria Botanical Gardens, the Pretoria zoo, the Union Buildings, where the President's office is located, and various museums and galleries.

For outdoor activities, visit the Wonderboom and Groenkloof Nature Reserves, the Austin Roberts Bird Sanctuary, or take a steam train ride around Pretoria. You could do a short horse trail at the Voortrekker Monument or through the Premier Game Reserve, seeing white rhinos and elands. With three big universities and many government departments based in Pretoria, the city is a vibrant place for both young and old people, with many world class shopping malls, hotels and camping sites. Due to the large student community, night life is also very lively in Pretoria.

Pretoria's Union Buildings.

Currently, there are discussions ongoing about renaming Pretoria to Tshwane, which was its original name before the Vortrekkers annexed and renamed it after one of their Afrikaner leaders, Andries Pretorius. But for me, the city will always be Pretoria, and I love it that way.

Bismark Mzubanzi Tyobeka is a Nuclear Engineer in the Nuclear Power Technology Development Section.

New Mexico, the Land of Enchantment

By Karen Edge

My adopted hometown is Cedar Crest, New Mexico. This is a small mountain town which was originally founded as a tuberculosis sanatorium community, and is located on the eastern, 'back' side of the Sandia Mountains from Albuquerque. Since the biggest excitement there is when a bear or mountain lion wanders through, I thought I would expand out a bit and describe life in New Mexico.

Sandia Mountains, New Mexico, USA.

New Mexico became a state in 1912, but was settled by the Spanish in the late 1500s. It already had a very large Native American population at the time, primarily Pueblo Indians, Apaches and Navajos. Of the residents today, 46% are Hispanic, 41% are 'anglo' and 10% are Native American, which is very different than the USA in general. It is one of the largest states, as well as one of the least populated. New Mexico has 17 people per square mile, compared to the US average of 87. That means a lot of empty space to get out into. We have more sunny days than most places, and artists flock to the state for the light. Often the sun will be shining even while it's raining! The design on our state flag is the Zia Indian symbol for the sun.

Although there are no nuclear power plants in New Mexico, it is the site of much nuclear history. Most of you may have heard of a town called Los Alamos, as well as the Trinity Site in south-central New Mexico. The state is still a leader in energy R&D. Both Los Alamos and Sandia National Labs call New Mexico home, as well as a branch of the US Department of Energy. We have a large mineral supply, including uranium, natural gas, molybdenum, gold and silver, among others. We also have fantastic gold and silver smiths, and jewellery shopping is a must for visitors.

New Mexico has Carlsbad caverns and the more recently discovered Lechugilla caverns, one of the largest and not yet completely explored cavern complexes in the world. We have mountains and deserts, skiing and hiking, and red or green chile in all the local dishes, sometimes both. We can still get our kicks on Route 66. We have the longest aerial tram line in the USA, from Albuquerque to the top of the Sandia Mountains, 4.3 km long. There are 31 state parks,

Young native Americans from the Zuni Pueblo tribe.

including White Sands, the Gila, Elephant Butte, and parts of the Sandia Mountains are a declared wilderness area, the only one in a metro environment in the USA. We have Billy the Kid and Kit Carson, a couple of large lakes, Santa Fe and Taos, great spicy food and lots of culture. The state is called the *Land of Enchantment* for good reasons, once you go and spend time there, you will always want to come back again.

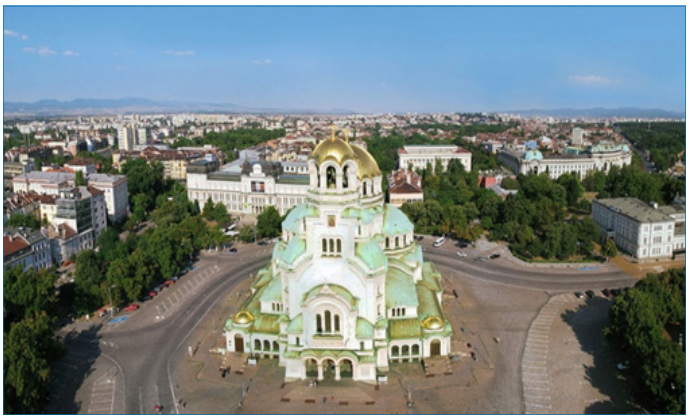
Karen Edge is the Nuclear Energy Series Coordinator, Nuclear Power Engineering Section

Sofia – Growing without Aging

By Tsvetelina Miliovska

Sofia, the capital of Bulgaria, is the city where I was born and grew up in an enchanting atmosphere of ancient history and vast green parks at the foot of Vitosha Mountain.

Sofia's history dates back to the 7th century BC, when the Thracians established a city around a mineral spring, which exists to the present day. The city has had several names in the different periods of its existence – it was called Triaditsa, Serdika or Sredets by the ancient Thracian tribe known as 'Serdi'. The current name, Sofia, derives from Greek and means 'holy wisdom'.



Alexander Nevski Cathedral in the center of Sofia.

Sofia is a modern European city with a unique look. It has managed to extract the best of every conqueror and preserved the spirit of vanished civilizations. The Saint George Rotunda in the heart of Sofia is Europe's oldest functioning church. Even nowadays, the town plans from Roman times are still preserved. Sofia combines the Western spirit, brought by Austrian, German and French architects at the beginning of the 20th century, with ancient Byzantine architecture of the many Orthodox churches and the neo-Byzantine look of a modern city.

Sofia by night

Many different religions and cultures mix in Sofia and build upon the city's heritage. Sofia is famous for its 'Square of Tolerance', which combines places of worship of four major religions: the 'Banya Bashi' Mosque, built in the 16th century, the Sofia Synagogue, the third largest synagogue in Europe, the Catholic Saint Joseph Cathedral and the Orthodox church 'Sveta Nedelia'.

Vitosha Mountain, overlooking the city of Sofia.

Sofia's motto is "growing without aging" and it is quite true. Sofia is not old, it is historic. All of Europe's history is represented within several square kilometres. A visitor can experience a journey from Rome to Constantinople, then see the world of the Sultans, pass through streets of Viennese and Parisian flair and end up at steel Communist style buildings.

This cultural heritage is surrounded by the beautiful scenery of Vitosha Mountain which is a popular ski resort overlooking Sofia.

Tsvetelina Miliovska works as a consultant in the INPRO Group.

Tula, Russian Federation

By Alexey Katukhov

Tula is a small, old town, located some 200 km south of Moscow. It was founded in 1146 and is famous for its arms, samovars and Leo Tolstoy. Until the 18th century, Tula was a minor fortress at the border of the Moscow principality, mostly inhabited by blacksmiths. In 1712, Tsar Peter the Great commissioned the blacksmiths to build the first armament factory in Russia. Several decades later, Tula was turned into the greatest ironworking center of Eastern Europe. The oldest museum in the city, showcasing the history of weapons, was inaugurated in 1724. The city has been a primary supplier of arms for the Imperial Russian Army, the Red Soviet Army and the modern Russian Army.

Old Russian Samovar

The town of blacksmiths also became famous as the centre of samovar manufacturing in the 18th century. Samovar manufacturing was also very profitable. Craftsmen quickly became manufacturers, and workshops turned into samovar factories. Samovars were made from cupronickel, red and green copper, brass and, in some cases, from silver. Sometimes they were plated with gold or silver. Samovars were literally used in every Russian household, and they were considered to be a symbol of comfort, hospitality and wealth.

Tula is the home town one of the world's greatest novelist, Leo Tolstoy. His two most famous works, the novels *War and Peace* and *Anna Karenina*, are acknowledged as two of the greatest novels of all times and a pinnacle of realist fiction. Tolstoy was born and spent most of his life in Yasnaya Polyana, the family estate near Tula.

Yasnaya Polyana, the Tolstoy family estate.

Alexey Katukhov is an Associate Nuclear Engineer in INIG.

Upcoming Events May–September 2012

Date	Title	Location	Contact
14–18 May	Third International Conference on Nuclear Power Plant Life Management	Salt Lake City, UT, USA	K-S.Kang@iaea.org
4–8 June	Technical Meeting on Synergistic Nuclear Energy Regional Group Interactions Evaluated for Sustainability (SYNERGIES)	IAEA, Vienna	V.Kuznetsov@iaea.org
11–13 June	International Workshop on Prevention and Mitigation of Severe Accidents in Sodium-cooled Fast Reactors	Fukui, Japan	S.Monti@iaea.org
18–20 June	Technical Meetings of the TWG-LWR and TWG-HWR	IAEA, Vienna	J.H.Choi@iaea.org M.Harper@iaea.org
18–20 June	Technical Meeting on the Evaluation Methodology of the Status of National Nuclear Infrastructure Development and INIR	IAEA, Vienna	M.Aoki@iaea.org
19–21 June	Technical Meeting of the TWG on Managing Human Resources	IAEA, Vienna	B.Molloy@iaea.org J.Isotalo@iaea.org
20–22 June	45th Annual Meeting of the TWG on Fast Reactors	Chicago, IL, USA	S.Monti@iaea.org
2–13 July	Technical Meeting on Leadership and Management of Nuclear Power Programmes	Paris, France	V.Nkong-Njock@iaea.org S.Koenick@iaea.org
11–13 July	19th INPRO Steering Committee Meeting	IAEA, Vienna	R.Beatty@iaea.org P.Gowin@iaea.org
10–13 July	Technical Meeting on Building a National Position	IAEA, Vienna	F.Bazile@iaea.org
23–27 July	Training Course on Natural Circulation Phenomena and Passive Safety Systems in Advanced Water Cooled Reactors	Corvallis, OR, USA	J.H.Choi@iaea.org
30 July–3 August	INPRO Dialogue Forum on Drivers and Impediments for Regional Cooperation on the Way to Sustainable Nuclear Energy Systems	IAEA, Vienna	V.Kuznetsov@iaea.org
6–10 August	Technical Meeting on Feasibility Study Guide for the Introduction of Nuclear Power Project	IAEA, Vienna	K-S.Kang@iaea.org
27–31 August	INPRO Dialogue Forum on Long-term Prospects for Nuclear Energy in post-Fukushima	Seoul, Rep. of Korea	P.Park@iaea.org
3–6 Sep	5th RCM of the CRP on Heat Transfer Behaviour and Thermo-hydraulics Code Testing for Supercritical Water Cooled Reactors (SCWRs)	Beijing, China	K.Yamada@iaea.org
3–6 Sep	Technical Meeting on Environmental Impact Assessment for SMR Deployment in Newcomer Countries	IAEA, Vienna	M.Subki@iaea.org
10–21 Sep	Technical Meeting on Management Systems for Nuclear Power Programmes and Safety Culture	Argonne, IL, USA	J.Boogaard@iaea.org
23–26 Sep	Technical Meeting on Economics and Cost Evaluation of Nuclear Power Plants	Denver, CO, USA	XP.Li@iaea.org
24–28 Sep	Technical Meeting on Public Information and Understanding	IAEA, Vienna	K-S.Kang@iaea.org M.Maeoka@iaea.org

Impressum

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