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Nuclear Power Newsletter

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Human Resource Development for Nuclear Power Programmes

From 12 to 16 May 2014, the IAEA is convening an International Conference on Human Resource Development for Nuclear Power Programmes: Building and Sustaining Capacity – Strategies for Education and Training, Networking and Knowledge Management, in Vienna, Austria.

Some 300 international experts, decision makers, government officials, regulators and industry representatives are expected for this event, which follows the first major conference on human resource development for introducing and expanding nuclear power programmes, held in Abu Dhabi, United Arab Emirates, in 2010.

Capacity building is a major first step in the process of ensuring that a qualified workforce is available and ready to assume the responsibility for safe, responsible and sustainable use of nuclear technologies. Capacity building needs to be sustained throughout the life of a nuclear power programme. The IAEA Action Plan on Nuclear Safety (2011) underlined the importance of capacity building: one of the actions calls upon both operating and 'newcomer' Member States to strengthen, develop, maintain and implement their capacity building programmes. Also, the critical role of human resources and capacity building in developing and maintaining nuclear infrastructure was reiterated by subsequent international experts' meetings related to this topic.

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The IAEA is pleased to announce that Mr Pál Kovács, Minister of State for Energy Affairs at the Ministry of National Development of Hungary has accepted the role of President of the 2014 Conference. Individual session chairs will represent newcomer and operating countries, heads of organizations leading nuclear power programmes, regulatory bodies, technical support organizations and nuclear power plants. Interest has been high in the international community, which is evident from the high number of expected participants as well as from the 137 papers submitted.

The conference focuses on the global challenges of capacity building, human resource development, education and training, nuclear knowledge management and establishing and maintaining knowledge networks. In particular, the conference reviews developments in the global status of human resource development since the 2010 international conference, emphasizes the role of human resources and capacity building programmes at the national and organizational level for achieving safe, secure and sustainable nuclear power programmes, and discusses the importance of building competence in nuclear safety and security.

The conference provides also a forum for information exchange on national and international policies and practices and allows participants to share key elements and best practices related to the experiences of Member States that are introducing, operating or expanding nuclear power programmes. Several key issues have been identified as topics for the five conference sessions:

Human Resources and Capacity Building: this session addresses current global demand for, and supply of, human resources for nuclear power programmes, reviews initiatives being taken by various organisations, and presents initiatives to enhance understanding of the relationship between nuclear safety and security.

Building and Sustaining Capacity through Education and Training: this session addresses education and training, from specific programmes in different organizations or countries, to common challenges and innovative tools and techniques. This session also discusses lessons learned in the assessment of training needs and the application of a model for a competency framework.

The IAEA assists Member States in training the next generation of nuclear professionals. (Photo: IAEA)

Preparing the Next Generation of Nuclear Professionals: this session focuses on how to attract the next generation of professionals to the field of nuclear power, how to reach out to young people through education and how to converge education and training activities.

Knowledge Management: this session addresses good practices and lessons learned in nuclear knowledge management, its integration into day-to-day activities and various implementation issues. It will also provide a forum for discussion of knowledge management in countries which are in different phases of a nuclear power programme and newcomer countries' needs.

Knowledge Networks: This session discusses several nuclear knowledge networks and related initiatives and programmes. The session also looks at the experiences of global, regional and topical networks and methods to improve their sustainability.

The **2014 International Conference on Human Resource Development for Nuclear Power Programmes: Building and Sustaining Capacity** is organized jointly by the IAEA Department of Nuclear Energy and the IAEA Department of Nuclear Safety and Security. More information can be found at the conference web page:

http://www-pub.iaea.org/iaeameetings/46084/International-Conference-on-Human-Resource-Development-for-Nuclear-Power-Programmes-Building-and-Sustaining-Capacity

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New Modules in IAEA E-learning Series for Nuclear Newcomers

Two new modules are available in the IAEA e-learning series for nuclear newcomers:

Module 8: Management Systems explains why management systems are needed when implementing a nuclear power programme and outlines the steps to develop, implement and continually improve it.

Module 9: Establishing the Safety Infrastructure for a Nuclear Power Programme defines a nuclear power safety infrastructure and explains its importance in a nuclear power programme.

This e-learning project is supported by an extrabudgetary contribution from the Republic of Korea under the IAEA Peaceful Uses Initiative. It is implemented by the Nuclear Power Engineering Section (NPES) and the Nuclear Infrastructure Development Section (NIDS) of the IAEA Division of Nuclear Energy.

All modules are based on the IAEA publication "Milestones in the Development of a National Infrastructure for Nuclear Power" (IAEA Nuclear Energy Series No. NG-G-3.1), other relevant IAEA publications and current experiences from newcomer countries.

www.iaea.org/NuclearPower/Infrastructure/elearning/index.html

Participants from 20 Member States attended the IAEA Workshop on Energy Assessments and Pre-feasibility/Feasibility Studies for Nuclear Power Programmes held in Seoul, Republic of Korea, on 17–21 March 2014. (Photo: KNA)

Energy Assessments and Feasibility Studies for New Nuclear Power Programmes

A number of IAEA Member States are at a very early stage of considering nuclear power for their national energy mix. One early step in this process is conducting a pre-feasibility study to assess the viability of introducing nuclear power under country-specific conditions.

A pre-feasibility study helps answer questions that may be raised by different stakeholders, such as: Why nuclear power? Would nuclear power be competitive? Is nuclear power safe? How could a nuclear power programme be financed? What would be the environmental impacts? Can nuclear power help combat climate change? What about nuclear waste?

A number of countries that are already embarking on a new nuclear power programme and have undertaken such feasibility studies have requested additional guidance and training in this area from the IAEA. Therefore, the IAEA, with support from the Korea Nuclear Association for International Cooperation (KNA), held a workshop in Seoul on 17–21 March 2014 which addressed first steps to be taken and provided guidance and training in conducting energy assessments, pre-feasibility and feasibility studies for the introduction of nuclear power in a national energy mix.

"A pre-feasibility study is normally the starting point and addresses the overall nuclear power programme and national strategy", explained Ahmed Irej Jalal, IAEA Scientific Secretary of the Meeting. "A full feasibility study provides the justification for the first nuclear power project and describes how it would be implemented". Mr Ahn Hong Jun, Chairman of KNA, added that "a feasibility study is very important when developing a new nuclear power project. It will help determine how the first nuclear power project can be completed within the defined budget and schedule while meeting all quality and safety requirements".

The workshop sessions addressed nuclear power and energy policy; main issues connected with pre-feasibility studies for the introduction of a nuclear power programme; and main technical aspects of feasibility studies. Thirty-one participants from 20 Member States presented their countries' status and challenges faced. They also discussed the scope of the assessments and studies for specific countries or regions that would be required in the decision making on a new nuclear power programme. Participants were also introduced to IAEA support in the areas of energy planning, project management, human resource management and preparing a feasibility study.

Group discussion during the Workshop. (Photo: KNA)

A technical tour included a visit to the Doosan Instrumentation and Control Center near Seoul and the Korea Atomic Energy Research Institute (KAERI) in Daejon.

Documents and presentations from the **IAEA Workshop on Energy Assessments and Pre-feasibility/Feasibility Studies for Nuclear Power Programmes** are available at http://www.iaea.org/NuclearPower/Meetings/2014/2014-03-17-03-21-WS-INIG.html.

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More on… Nuclear Power Engineering

New Service to Review Readiness for Constructing Nuclear Power Plants

The IAEA has introduced a new service for Member States starting nuclear new build or major refurbishment construction activities.

The **Construction Readiness Review (CORR)** service is aimed at assessing a nuclear project's readiness to proceed to its next phase of construction. A CORR mission can be deployed prior to the start of a major construction, at a major project milestone, or as otherwise requested by a Member State. Organizations in Member States such as nuclear utilities, owners, regulators and technical support organizations can benefit from such reviews.

The assessment includes a review of planning processes, preparedness for subsequent project phases, major risks and issues, and engineering and construction readiness. The mission team will include international experts, similar to the IAEA's Integrated Nuclear Infrastructure Review (INIR) or Operational Safety Review Team (OSART) missions.

Member States can request a CORR Mission prior to starting major construction. (Photo: ENEC)

CORR missions will cover areas such as project management, engineering readiness, i.e. engineering deliverables required to support construction, procurement, material and supply chain readiness, i.e. materials available to support construction activities, quality management and records, human resources and training, construction readiness, construction installation completion assurance and system turnover process, target area reviews, including project delays and corrective actions, and technical visits to specific sites and locations as requested.

A recent IAEA publication, entitled *CORR Guidelines: Preparing and Conducting Review Missions of Construction Project Readiness for Nuclear Power Plants* (IAEA Services Series 24) outlines the concept and the process of the missions (see p. 14).

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Nuclear I&C Application of Field Programmable Gate Arrays

The application of field-programmable gate arrays (FPGAs), is gaining increased importance worldwide in nuclear power plant I&C systems, notably for safety and safety-related applications.

New nuclear power plants are being designed mostly with programmable, digital instrumentation and control (I&C) systems. Plants designed earlier are or will face the need to replace or upgrade their old analogue and digital I&C equipment to cope with aging and obsolescence.

Historically, the majority of the digital I&C systems have been based on software controlled microprocessor technology. Obtaining regulatory approval for these software-based systems in new and existing plants can be costly and time-consuming, causing implementation delays.

An alternative solution to this issue is the application of field-programmable gate arrays (FPGAs), which are gaining increased importance worldwide in nuclear power plant I&C systems, particularly for safety and safety-related applications.

Nuclear power plant operators and equipment suppliers see potential advantages of FPGA-based digital I&C systems, as compared to microprocessor-based ones, especially where systems need to be qualified and licensed.

This is because FPGA-based systems can be made simpler, more testable, less reliant on complex software, e.g., operating systems, and easier to qualify for safety and safety-related applications. FPGAs also offer an excellent solution when diversity is required. FPGA-based systems are now finding their way in new plant I&C designs, as well as in replacements and upgrades for operating plants.

Due to the considerable potential for, and interest in, FPGA-based applications, in 2013 the IAEA initiated a publication on the application of FPGAs in I&C systems in nuclear power plants to assist plant owners, suppliers, regulators and researchers in their work.

A team of six experts from four Member States met at the IAEA in March 2014 and finalized the manuscript of the new IAEA Nuclear Energy Series report, covering different aspects of the application of FPGAs in nuclear power plants.

The publication on *Nuclear I&C Application of Field Programmable Gate Arrays—FPGAs* will fill a gap for all stakeholders in the nuclear application of FPGAs, as no aspects of the design, qualification, implementation, licensing, and operations of FPGA-based systems has yet been described in detail in an IAEA publication. The release of the report is foreseen for late 2014.

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Nuclear Infrastructure Development

INIR Mission Report Presented to Turkey's Government

Following an Integrated Nuclear Infrastructure Review (INIR) Mission to Turkey in November 2013, Alexander Bychkov, IAEA Deputy Director General and Head of the Department of Nuclear Energy, delivered the final mission report to the Turkish Government on 20 February 2014.

IAEA Deputy Director General Alexander Bychkov delivers the INIR mission report to Undersecretary Metin Kilci, Ministry of Energy and Natural Resources, Ankara, Turkey. (Photo: MENR)

From left: Necati Yamac, Head of the Nuclear Power Implementation Department, MENR; Ilker Sert, Deputy Undersecretary, MENR; DDG Bychkov; Undersecretary Metin Kilic; Anne Starz, Acting Section Head, IAEA Nuclear Infrastructure Development Section. (Photo: MENR)

The report concludes that Turkey has made important progress in the development of nuclear infrastructure for its nuclear power programme and that strong government support for the project is evident, with effective mechanisms for coordination among the individual institutions. The report acknowledges that this is the first time a country is using a Build-Own-Operate (BOO) approach for a nuclear power project. The report makes 24 recommendations and 15 suggestions to assist the national authorities in further preparing the infrastructure necessary for the project. The main recommendations to Turkey include enacting a law on nuclear energy which establishes an independent regulatory body and putting a national policy in place that covers a wide range of issues, as well as further developing the required human resources.

Turkey decided to include nuclear power in its energy mix to meet the increasing demand for electricity and support its economic development. The share of nuclear power in Turkish electricity generation is aimed to reach 10 per cent by 2023. In May 2010, an Intergovernmental Agreement (IGA) was signed with the Russian Federation for the construction and operation of the first NPP at the Akkuyu site as a BOO project. A project company, Akkuyu Nuclear Power Plant Electricity Generation Joint-Stock Company (Akkuyu Project Company, APC), was established. It is expected that a construction license application will be submitted in 2014. Turkey is also developing another project at Sinop with Japan.

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National Workshop on Industrial Involvement in Algeria

Under an IAEA TC Project (ALG/2/009), a national workshop was held in Algiers on 17-20 March 2014 to assist the government and/or future owner/operator in assessing the contribution of the national industry to a nuclear power programme.

Representatives from the IAEA's Nuclear Infrastructure Development Section participated in the workshop related to issues of industrial involvement. The workshop included over 100 representatives from various industries in Algeria, as well as the Algerian Atomic Energy Commission. During the workshop, experts from Argentina, Japan, the Republic of Korea and several European countries shared case studies and lessons learned regarding industrial involvement during the development and expansion of nuclear power programmes. Participants from Algeria also provided an overview of the country's industrial capabilities, which were further discussed in focused breakout sessions.

As a next step, Algeria intends to consider the creation of an industrial forum to ensure effective involvement of its industry during the development of a nuclear power programme.

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2014 Annual Nuclear Infrastructure Meeting

The IAEA's annual Technical Meeting on Topical Issues in the Development of Nuclear Power Infrastructure is the main forum for senior managers and experts involved in developing new national nuclear power programmes to meet and discuss challenges and common issues. This year's meeting was held on 4–7 February 2014 at the IAEA.

Around 100 participants from 41 Member States, representing government ministries, organizations responsible for nuclear power programme planning in newcomer countries, current and future owner-operator organizations, vendors, technical support organizations, universities and regulatory agencies, attended the 2014 meeting.

Nine plenary sessions provided opportunities for participants from operating and newcomer countries to share their experiences on common infrastructure development issues. The UK experience with new builds was highlighted from the perspectives of the government, the regulatory body and two owner-operators. Breakout sessions addressed case studies from newcomer countries to highlight specific aspects of infrastructure development.

The challenges in countries building their first nuclear power plant and countries expanding their existing programme are similar in many respects. **Strong government support with a firm road map for progress is one of the most important factors to success.** Also, support from national and local stakeholders is essential. Financing is one of the biggest challenges and requires careful management and allocation of the financial risk among the partners of the project. Some countries are also taking a proactive role in creating a favourable investment environment for nuclear power through purchase power price agreements or other guarantees.

A successful nuclear power programme starts with a strong justification: different countries may value the nuclear contribution to their energy mix for different reasons, including security of supply, mitigation of climate change and affordability. Countries emphasized as their rationale the State's analysis of, and commitment to, a diversified supply of electricity and the need to meet future demand.

Newcomer countries face challenges in setting up an appropriate legislative and regulatory infrastructure and building the necessary institutions, with a clear allocation of roles and responsibilities for the government body, regulator, owner and future operator. Radioactive waste management needs to be addressed early in the project, i.e. low and medium level waste from operation and high level waste and spent fuel.

Concerning stakeholder involvement, early engagement is essential to create trust and confidence, both at national and local levels. Many questions from local communities are of a more general nature, such as how the plant construction will affect the community and people living around the power plant. Participants emphasized the importance of seriously considering the concerns of stakeholders.

Closing Session of the Annual Infrastructure Meeting; From left: A. Howard, Co-Chair, USA, DDG Bychkov, F. Osaisai, Co-Chair, Nigeria, J.K. Park, Director, Div. of Nuclear Power, J. Lyons, Director, Div. of Nuclear Installation Safety, A. Starz, Acting Section Head, Nuclear Infrastructure Development. (Photo: IAEA)

Forming strategic alliances with different partners and utilizing the competencies that are imbedded in the supply chain can be an important means to build capacity. This does not replace the need for a competent owner-operator, an 'intelligent customer' who can manage the supply chain and fulfil the prime responsibility for safety. Countries introducing nuclear power are exploring a variety of contractual arrangements concerning engineering and operating competencies. Human resource development remains a priority for embarking and experienced countries alike.

The importance of international cooperation is essential to learn from others and gain experience. The participants emphasized that for many years the IAEA has been the place where countries share their experience and that the IAEA is delivering valuable services on building a nuclear power infrastructure. The meeting also provided an opportunity to receive Member States' inputs to the revision of the IAEA Milestones document (IAEA Nuclear Energy Series NG-G-3.1). The importance of IAEA peer review missions for newcomer and expanding countries, including Integrated Nuclear Infrastructure Review (INIR) and Integrated Regulatory Review Service (IRRS) missions were highlighted.

Participants provided very positive feedback, confirmed that the balance between plenary sessions and breakout sessions was good and appreciated the fact that presentations were concise and that the schedule included sufficient time for questions and answers. What participants liked the most was the information about Turkey's Build-Own-Operate (BOO) model, the session on the UK, since it shared real-life experience from different angles (government, regulator, utilities), lessons learned in China and the breakout sessions with case studies.

For next year, participants suggested focusing on financing models, options for the owner-operator, communication and public acceptance, Turkey's experience, and radioactive waste management.

All presentations are available at http://www.iaea.org/NuclearPower/Meetings/2014/2014-02-04-02-07-TM-INIG.html

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Becoming a Knowledgeable Customer in a Nuclear Power Programme

How future owners/operators of nuclear power plants can become 'knowledgeable customers' was the focus of an IAEA Technical Meeting, which was held on 7–11 April 2014 at the ROSATOM Central Institute for Continuing Education and Training (CICE&T) in Obninsk, Russian Federation.

The meeting was hosted by the Government of the Russian Federation through the State Atomic Energy Corporation ROSATOM. It provided an opportunity for exchange of information among countries which are developing their nuclear power programme as well as sharing experiences from case studies and existing nuclear power programmes. Participants from ten IAEA Member States attended the meeting: Belarus, China, Egypt, France, Jordan, Nigeria, the Russian Federation, UK, USA and Viet Nam.

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 of the nuclear power plant (NPP), should be charged with the responsibility to realize the completion of the NPP project. During this process, it is important for the future owner/operator to become a 'knowledgeable customer', especially when dealing with the 19 nuclear infrastructure issues outlined in the IAEA Milestones approach. **Knowledgeable customers know what to ask for, how to ask for it, and know how to check that what they received is what they had asked for.**

The concept of a 'knowledgeable customer' was first presented at a workshop in Paris in 2012. The Technical Meeting in Obninsk further developed the concept, based on feedback from Member States, and covered detailed and practical steps that should be taken by an organization. This includes main features of a knowledgeable customer; clarifying roles and responsibilities of owner, operator, vendor, advisor, owner engineer, etc.; being a knowledgeable customer under different ownership and contracting options; how to develop the capability to become a knowledgeable customer; case studies and strategic partnerships; and expectations and key attributes of a knowledgeable customer, including legal aspects.

The meeting also included a technical visit to the Novovoronezh NPP, which has operating units, units under construction as well as units under decommissioning.

Technical Visit to the Novovoronezh NPP. (Photo: Rosenergoatom)

This was an excellent opportunity to see the early VVER 440, VVER 1000 and the construction site of the latest VVER AES 2006 design, which serves as reference plant for the Akkuyu NPP project in Turkey. Participants also visited the simulator used on site to train operators and discussed training policies with experts of Rosenergoatom.

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What Newcomers Need to Know About Nuclear Power Programmes

by J.K. Park, Director, Division of Nuclear Power

Nuclear newcomers' desire for nuclear power has not decreased even after the accident at Fukushima Daiichi Nuclear Power Station in Japan. Many countries are either considering nuclear power or actively preparing their infrastructure for a possible nuclear power programme. Initiating a nuclear power programme raises many questions. How do I start? Where will I find the people and the money to develop the programme? Is there a site with the right requirements and the necessary public support to proceed? And in light of Fukushima, is it safe?

In a commentary published online in ASIANPOWER on 24 February 2014, Division Director J.K. Park addresses these questions and explains how the IAEA helps its Member States in developing the necessary infrastructure for a new nuclear power programme. Read the full article at:

http://asian-power.com/project/commentary/what-newcomers-need-know-about-nuclear-power-programmes

Nuclear Power Technology Development

Developing a Technology Roadmap for SMR Deployment

As IAEA Member States are becoming increasingly interested in the near term deployment of small and medium sized reactors (SMRs), the IAEA has started a project to develop a 'technology roadmap' for SMR deployment.

Technology roadmaps are planning tools to align the development of scientific or engineering products with their supporting technologies. Technology roadmapping is part of a methodology that guarantees the alignment of investments in technology and the development of new capabilities. As a proven management tool, technology roadmaps are used for identifying, evaluating, communicating, and promoting the development of complex technology projects.

For IAEA Member States, technology roadmaps can inform science, engineering and technology policy and aid in making investment decisions across government and industry in terms of loan guarantees and incentives, industry-led initiatives, and human resource development. While there has been a number of technology roadmaps for nuclear energy development by various organizations, this will be the first one specific to SMRs.

The IAEA Technology Roadmap for SMRs will be developed with input from Member States, through a series of technical and consultants meetings. The roadmap will be documented in a new IAEA Nuclear Energy Series publication, titled *Technology Roadmap for Small and Medium Sized Reactor Deployment*. Publication is anticipated for 2016. The document will review progress related to SMRs currently under construction and share lessons learned associated with their deployment. In addition, the document will present two distinct types of roadmaps: one roadmap for SMRs possessing a relatively high state of technology readiness and one for reactors that have much lower readiness states.

Small and Medium Sized Reactors

Most nuclear power plants currently under construction, and many that are in operation, have power levels of up to 1700 MW(e) and are designed based on an evolution in light water reactor technology. The newer designs incorporate a greater use of passive safety systems, i.e., systems that in principle require no operator action and no electrical power to function properly, to improve plant safety. However, SMRs are currently under development around the world and some are moving rapidly towards deployment. The IAEA classifies 'small reactors' as reactors with an equivalent electric power output of less than 300 MW(e) and 'medium sized reactors' as reactors with an equivalent electric power of between 300 and 700 MW(e). One of the recent advancements has been on the development of small modular reactors defined as those reactor designs that are ≤300MW(e), and fabricated in modules that are transportable from the factory to the site by rail, truck, or barge.

At present, four SMRs are under construction in the following countries: Argentina, China, India, and the Russian Federation. Moreover, research, development, and licensing activities are being carried out in 11 Member States (Argentina, Canada, China, France, India, Italy, Japan, Republic of Korea, Russian Federation, South Africa, and United States of America) on approximately 45 advanced SMR concepts to provide carbon-free energy for electricity generation, process heating, desalination, and hydrogen generation. The SMR concepts under development utilize not only light water reactor (LWR) technology, but also technologies associated with heavy water reactors (HWRs), gas-cooled reactors (GCRs), liquid metal-cooled reactors (LMCRs), and molten salt reactors (MSRs).

Interest in this emerging technology by Member States is primarily being driven by concerns related to rising demand for electricity and energy security, climate change and continued reliance on fossil fuels, and integration of new power generating capacity into existing grids with limited transmission capacity.

SMRs promise the following technological and economic advantages over large reactors:

- Enhanced safety and security features;
- Ideally sized to replace retiring older coal fired units and suitable for countries with smaller electrical grids;
- Modular factory construction promises reduced costs and enhanced quality;
- Shorter construction time reduces overall financing costs;
- Lower initial capital investment for n^{th}-of-a-kind plant;
- Additional modules can be added for marginal costs as demand for energy grows;
- SMRs can be located near industrial activities to provide energy for non-electricity applications, i.e., process heat, desalination, district heating, etc.;
- SMRs can be located in remote areas or on small islands.

Moreover, a number of SMRs currently under development are fast-spectrum reactors that can achieve high conversion ratios to improve long term fuel utilization and sustainability. Some of these are being designed to incorporate a 'breed and burn' concept to minimize the need for enrichment and back-end fuel recycling and reduce the need for building geological repositories since there will be less spent fuel. Others are being designed as waste burners to produce energy while destroying the long term hazardous actinides residing in today's used nuclear fuel.

The *Technology Roadmap for Small and Medium Sized Reactor Deployment* is being developed by the Nuclear Power Technology Development Section (NPTDS), in cooperation with the Nuclear Infrastructure Development Section (NIDS), the INPRO Section, the Planning and Economic Studies Section, and the Division of Nuclear Fuel Cycle and Waste Technology, all in the Department of Nuclear Energy.

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Using HTGRs for Energy Neutral Mineral Processing

High Temperature Gas-cooled Reactors (HTGRs) with their associated high outlet temperatures (≈950˚C) are a promising technology for direct heat applications in various industries. A new IAEA Coordinated Research Project (CRP) will take advantage of this feature and focus on the use of HTGRs for energy intensive mineral processing.

The IAEA's Nuclear Power Development Section and the Nuclear Fuel Cycle and Materials Section recently initiated a CRP to investigate the applicability and potential of using HTGRs to power energy intensive mineral development processes. Some ores, such as phosphate-, copper- and gold ores that are processed, often also contain considerable amounts of uranium (U) and/or thorium (Th). As first proposed by Haneklaus et al. (*Using HTGRs for greenhouse gas reduction and energy neutral production of phosphate fertilizers*, Annals of Nuclear Energy, *submitted*), the accompanying U/Th could be recovered, and after fuel manufacturing be used to power a HTGR capable of providing the energy needed for mineral processing and nuclear fuel recovery. The figure below illustrates the alternative process chain for energy neutral processing of phosphate fertilizer from phosphate rock. First estimates showed that in case of phosphate rock with average uranium concentrations (100 ppm), far more uranium is recovered than needed to run a HTGR of sufficient size to power the mineral development and the uranium/thorium recovery.

The CRP will consider different energy intensive mineral development processes (phosphate rock, gold, copper, rare earth elements, etc.) with or without accompanying U/Th recovery, where the deployment of HTGRs could mitigate greenhouse gas emissions and allow an environmentally friendly production of final products of higher quality, e.g. thermal phosphoric acid from low grade phosphate rock. The CRP has already attracted considerable interest among IAEA Member States including Chile, Egypt, Germany, Indonesia, Morocco, South Africa, Spain and the USA. A first consultancy meeting is proposed for later this year.

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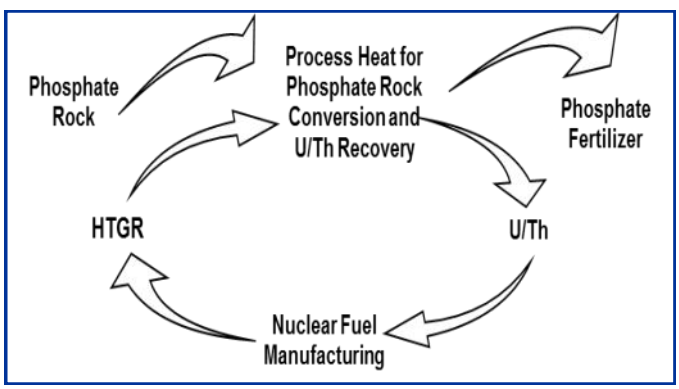

Alternative process chain for energy neutral processing of phosphate fertilizer from phosphate rock.

Safety of HTGRs in the Light of the Fukushima Daiichi Accident

Following the Fukushima Daiichi nuclear accident, the safety of all nuclear installations remains a main concern, and all developers of nuclear reactor technologies have an added responsibility to demonstrate that whatever nuclear reactor design they propose, it will be able to survive the challenges that befell the Fukushima NPP.

The properties of modular HTGRs can minimize, and in many cases eliminate concerns with offsite and onsite AC power, and the need for active safety systems and required operator actions to avoid large radionuclide releases from the plant site. Despite these favourable characteristics, the reactor designer must still assure a safe design.

Developing and implementing safety design criteria that take the specific characteristics of HTGRs into account would provide a high level of assurance that HTGRs are consistently designed, constructed, and operated in a manner that takes advantage of these intrinsic properties, while also avoiding unintended compromises in plant safety.

A wealth of safety design experience is available from the previous operating HTGRs in Germany and the USA, the current research reactors in Japan and China and the High Temperature Reactor Pebble-bed Module (HTR-PM) demonstration plant under construction in Shandong Province, China.

Some 20 experts from 12 Member States and international organizations met at an IAEA Technical Meeting on 8–11 April 2014, to present and discuss two main HTGR safety focus areas in the light of the Fukushima accident: HTGR safety design features that illustrate how the design will be able to survive the challenges that befell the Fukushima NPP, and other postulated design basis and design extension conditions, as well as aspects of HTGR safety research. The technical presentations confirmed that HTGRs, when designed appropriately (e.g. relatively low power density with inherent decay heat removal), would have good chances to survive events that were once considered far beyond design limits.

The meeting participants, comprised of researchers and engineers performing safety research or technology development work on HTGRs, also discussed the technical scope of the proposed IAEA Coordinated Research Project on Modular HTGRs Safety Design (CRP I31026), the potential contributions from Member States, and the expected contribution of the CRP to the implementation of the IAEA Action Plan on Nuclear Safety. They reached a common understanding of the safety approach and process to be studied. The CRP results will be reported in an IAEA technical document, which is intended to serve as a guideline for future HTGR safety designs.

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Recent trends and priorities in fast neutron systems modelling and simulation

The successful development of innovative fast neutron systems is strongly linked to powerful and reliable calculation methods and simulation tools for the design and safety assessment of these systems.

Given the wide range of activities and strong interest in numerous IAEA Member States in this area, a Technical Meeting on Priorities in Modelling and Simulation for Fast Neutron Systems was held at the IAEA on 14–16 April 2014. "The IAEA plays a fundamental role in supporting Member States in improving the design and safety features of their nuclear systems", said Alexander Bychkov, IAEA Deputy Director General and Head of the Department of Nuclear Energy. "Our Department has been very active in this area. Several coordinated research projects (CRPs) on analytical and experimental benchmark analyses for fast reactors were recently concluded or launched. I would like to thank all Member States which have shared their valuable information and experimental data with the IAEA and other CRP participants", Mr Bychkov added.

Some 30 experts from 15 Member States and two international organizations involved in fast neutron system development programmes attended the meeting, chaired by Justin Thomas from the US Argonne National Laboratory. They reviewed national and international programmes on fast neutron systems, with particular emphasis on activities aimed at developing and improving modelling and simulation capabilities, and verifying and validating advanced nuclear codes. The meeting participants identified priorities and proposed future international activities.

"Given the broad spectrum of possible benchmark activities, we need advice from experts in Member States to set priorities and embark on a programme that fits the actual needs of our Member States", said Stefano Monti from the IAEA Nuclear Power Technology Development Section, who was the Scientific Secretary of the meeting.

The main outcomes of the meeting will be presented and further discussed at the annual meeting of the Technical Working Group on Fast Rectors (TWG-FR), to be held on 19–23 May at the IAEA. TWG members will be asked to consider and endorse the recommended priorities on modelling and simulation for fast neutron systems.

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Catalogue on Experimental Facilities for Liquid Metal Cooled Fast Neutron Systems

The IAEA has launched a new activity to prepare a Catalogue on Experimental Facilities for Development and Deployment of Liquid Metal Cooled Fast Neutron Systems (LMFNS), a useful tool for bilateral or multi-lateral collaboration in the field.

A new study, proposed at the IAEA Technical Meeting on Existing and Proposed Experimental Facilities for Fast Neutron Systems in June 2013, will identify experimental facilities for fast neutron systems currently operated, developed or planned by national and international programmes. All IAEA Member States with relevant fast neutron system projects are participating in this project. The study aims to harmonize research and technology development and deployment of innovative fast neutron systems at the international level.

Experts from ten Member States, which are contributing to this new initiative, met at the IAEA on 25–27 March 2014 and agreed on a detailed work plan, time schedule and structure of the Catalogue, and defined how to collect the required information. A first draft of the Catalogue will be prepared by the end of this year. The Catalogue will be published in the IAEA Nuclear Energy Series in 2015.

This activity complements the recently launched IAEA Coordinated Research Project on Sodium Properties and Safe Operation of Experimental Facilities for the Development and Deployment of Sodium Cooled Fast Reactors, which will benefit from the outcomes of this study.

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Experimental Facility in Support of Heavy LMFNS, Karlsruhe Institute of Technology (KIT), Germany. (Photo: KIT)

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

Effective Cooperation between GIF and INPRO Continues

Safety, proliferation resistance and economics of innovative nuclear reactors continue to be key areas of cooperation between INPRO and the Generation IV International Forum (GIF).

Some 40 experts of both organizations met at the IAEA in Vienna on 4–5 March 2014 to share information on progress and future activities related to R&D and technology innovations of nuclear energy systems and discuss topics of future cooperation. This was the 8th Interface Meeting between the two organizations since 2003.

"The basis for initiating cooperation was the recognition of complementary activities, primarily in the realm of technology assessment methodology development", said John E. Kelly, the Chair of GIF. "Our Joint Action Plan has evolved into a cooperation matrix that we actively maintain today".

"I am very pleased that this important technical exchange between the IAEA and the Generation IV International Forum continues", said Alexander Bychkov, IAEA Deputy Director General and Head of the Department of Nuclear Energy, who is also the INPRO Project Manager. "The topical sessions on the current cooperation between the IAEA and GIF show the promise in our continued dialogue. The sessions on safety and economics suggest that our cooperation will continue in the future".

GIF coordinates research activities on six next generation nuclear reactor systems: sodium cooled fast reactor (SFR), lead cooled FR (LFR), gas cooled FR (GFR), molten salt reactor (MSR), supercritical water cooled reactor (SCWR) and very high temperature reactor (VHTR).

GIF representatives presented the technical development status of each of these reactors within the participating GIF Member States. Russia is moving into a number of demonstrations including the current fuelling of the BN-800 and SVBR-100 and BREST demonstrations in the 2020 time frame. The MBIR liquid metal cooled fast research reactor is currently under construction to support RD&D efforts in this area. New demonstration fast reactors are also operating or being constructed in China and India. In Europe, France, Italy, Romania and other EU countries continue to work together on fast reactor designs, moving toward demonstration projects. Elsewhere, significant fast reactor R&D is moving ahead, using existing research and demonstration reactors, in a collaborative atmosphere among Member States.

There has been important progress in the area of high temperature reactors, particularly in materials and fuels. The USA has recently reported outstanding results from irradiations and high temperature fuel tests on tristructural-isotropic (TRISO) fuel and there is growing interest in process heat applications.

Although the pace of fast gas reactor R&D seems to be slowing down, important advancements in materials within that programme may influence the future of fuels for reactors that are being built and demonstrated today.

Mr John E. Kelly (left) and DDG Bychkov opened the 8th GIF-INPRO Interface Meeting on 4 March 2014. (Photo: IAEA)

IAEA and GIF experts briefed the meeting on the status of assessment methodology development and cooperation in the areas of safety, proliferation resistance and economics. They also reported on the series of GIF-IAEA workshops on SFR safety aspects, including development of SFR safety design criteria (SDC). The next SFR-SDC joint workshop will be held on 10–11 June 2014 at the IAEA.

INPRO experts also briefed the meeting on ongoing and new projects of interest to GIF. This included an update on the SYNERGIES project that helps develop a more detailed understanding of how future innovative reactor and fuel cycle technologies, in different Member States, may operate in a cooperative manner to achieve a higher level of sustainability.

New INPRO projects briefed to GIF included activities focusing on sharing and development of best practices for international cooperation in development of innovation. In the area of innovative reactor R&D, GIF is an outstanding example of international collaborative efforts.

Two other briefed INPRO projects cover specific topics of interest to innovative reactor development, namely: waste generated from innovative reactors and fuel cycles (WIRAF) and assessment of innovative reactor concepts for prevention of severe accidents and mitigation of consequences (RISC). Finally, INPRO staff briefed the GIF participants on efforts to perform a set of limited scope Nuclear Energy System Assessments (NESA) on specific liquid-metal-cooled fast reactor (LMFR) designs. These assessment efforts would be done by Member States in bilateral collaboration with the INPRO Section. The next GIF-INPRO Interface meeting will be held in early 2015. All presentations are available at the http://www.iaea.org/NuclearPower/Meetings/2014/2014-03-04-03-05-INPRO-GIF.html

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INPRO: Connecting People

Several of INPRO's activities aim at sharing good practices in collaboration on innovations and preparing a new publication on the subject.

A Technical Meeting on "Effective Collaboration in the Development of Innovations to Support Sustainable Nuclear Energy Systems" took place on 8–11 April 2014. It was preceded by a consultants' meeting on the topic in November 2013. The 9th INPRO Dialogue Forum will focus on International Collaboration on Innovations: Towards Global Sustainable Nuclear Energy, and is planned for 18–21 November 2014. A survey is underway to collect data on collaboration mechanisms that will be used as case studies in the report. In addition, several consultants' meetings are planned for 2014 and 2015, to prepare the Dialogue Forum, share knowledge in areas such as management of intellectual property, and finalize the report for publication.

The April 2014 Technical Meeting on Effective Collaboration in Innovations attracted 47 participants from IAEA Member States and several IAEA programmes. They discussed measures to design effective collaboration mechanisms; future needs for collaboration on developing innovative solutions for infrastructure and institutional arrangements; practical aspects and issues of collaboration between technology holders and users; and the role of governmental coordination for a successful collaboration on innovations.

Participants in the Technical Meeting on Effective Collaboration in the Development of Innovations to Support Sustainable Nuclear Energy Systems, 8-11 April 2014. (Photo: IAEA)

The 9th INPRO Dialogue Forum on International Collaboration on Innovations: Towards Global Sustainable Nuclear Energy, to be held in November 2014 at the IAEA, will address four major topics: driving forces of collaboration on innovations; intellectual property management within collaboration on innovations; collaboration between technology holders and users in infrastructure and institutional arrangements for sustainable NESs; and how to increase the trust between partners involved in collaborations.

More information will be available soon at http://www.iaea.org/INPRO/DFs/index.html.

The INPRO Project itself can be considered an effective collaboration mechanism, having demonstrated its own capabilities and competences in this area.

INPRO has the 40 Members, including 12 countries embarking on or planning new nuclear power programmes. It conducts international collaborative projects, and has convened seven Dialogue Forums so far, each attracting numerous participants. It has developed and maintains the INPRO Methodology, used by both technology users and technology holders, to assess the sustainability of nuclear energy systems (NESs). INPRO's analytical framework and publications address not only technical and institutional aspects of innovations but also provide guidance for the assessment, development and deployment of sustainable NESs.

Over the years, INPRO has established effective collaboration with many national and international organizations, such as GIF, the European Sustainable Nuclear Energy Technology Platform (SNETP), the International Framework for Nuclear Energy Cooperation (IFNEC), OECD's Nuclear Energy Agency (OECD/NEA), the EC's Joint Research Centre (EC-JRC) and the European Nuclear Education Network (ENEN).

INPRO's activities connect people from various countries and organizations, at all levels, from researchers to senior governmental officials. And last but not least, INPRO is dedicated to the principles of teamwork.

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8th INPRO Dialogue Forum:
Economics, Resource Availability and Institutional Arrangements
26-29 Aug 2014, IAEA, Vienna, Austria

This INPRO Dialogue Forum will bring together nuclear technology holders, technology users and other stakeholders from interested Member States to discuss the roles of economics, resource availability and institutional arrangement for a sustainable development of nuclear energy systems.

The 8th INPRO Dialogue Forum will present a revision and updates of the INPRO manual's volumes on economics, environmental impact by depletion of resources, and infrastructure. It will invite views from national experts, technology holders and international organizations on sustainability issues related to economics, resource availability and institutional arrangement as discussed in the INPRO Methodology; confirm the validity of the INPRO assessment method for different types of nuclear energy systems in the area of economics, environmental impact by depletion of resources, and/or infrastructure; and harmonize the INPRO Methodology with other approaches by international experts and organizations.

The meeting is an activity under the IAEA TC Project INT2017 "Capacity building in long-range strategic nuclear energy planning for global sustainability".

Applications are invited through http://intouch.iaea.org **by 25 May 2014.**

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Preparing the KIND Collaborative Project

Innovative technologies to support future sustainable nuclear energy systems are being analysed and developed in many countries.

Since there are many such developments, Member States periodically need to evaluate the status, prospects, benefits and risks associated with the development of particular technologies as compared to others, in order to prioritize and adjust the allotment of financial and other resources for national programmes on innovative nuclear technology development.

Contrary to technologies that are available today or will be developed in the nearer future, detailed technical information and institutional norms may not be available for innovative technologies targeted at a more distant future. Moreover, an evaluation of innovative systems would benefit from a comparative analysis and assessment, which is typically not the purpose of available assessment tools, such as the INPRO Methodology for nuclear energy system assessment. This makes it necessary to involve expert opinions in those areas where design and other data are insufficient. However, opinions may differ among the different groups of experts. For an effective evaluation process, a methodology and tools will be required to combine expert opinions and arrive at an evaluation result which takes into account such uncertainties.

The **INPRO Collaborative Project on Key Indicators for Innovative Nuclear Energy Systems (KIND),** to be started by a technical meeting on 4–8 July 2014, has the objective to address these uncertainties and issues by developing guidance and tools for comparative evaluations of the status, prospects, benefits and risks associated with development of innovative nuclear technologies.

In particular, the new project will:

(1) develop a limited number of key indicators for the status, prospects, benefits and risks associated with innovative technologies and nuclear energy systems based on these technologies; and

(2) elaborate and adapt advanced methods to aggregate expert judgements in the assessments to facilitate comparative evaluations of innovative nuclear energy systems based on a defined set of key indicators.

The KIND project will develop guidance and tools to support Member States in prioritizing and adjusting the allocation of resources in national programmes on innovative nuclear technology development. The project will also produce inputs for further improvement of the INPRO Methodology so that it can be applied in comparative evaluations of innovative nuclear energy systems.

A preparatory consultants' meeting for task 1 of the KIND project took place on 26–28 March 2014 at the IAEA with five leading technical experts from India, the Russian Federation and the USA. Achieving the meeting's objectives, the experts agreed on basic principles of the assessment approach, and developed a set of key indicators for comparative assessment of innovative nuclear technologies and energy systems based on these technologies, while also linking them to subject areas and 'Basic Principles' of the INPRO Methodology and the GAINS analytical framework. The meeting defined the following basic principles for a comparative assessment:

- Areas of interest for the assessment should be selected from the subject areas of the INPRO Methodology;
- Key indicators should relate to certain basic principles of the INPRO Methodology;
- Areas of interest are the domain of policy makers;
- Each area of interest should be evaluated separately and transparently;
- Key indicators should be independent as much as reasonably possible, and be as few as reasonably possible;
- Complex mathematics and double counting should be avoided; and
- Simple summing up of indicators with weighting (importance) factors is recommended.

By screening the whole array of the INPRO indicators (125) and the key indicators of the GAINS analytic framework (10), as well as by adding some new indicators suggested by the experts, a set of key indicators was defined in the areas of economics (2), waste management (1), proliferation resistance (3), environment (1) and safety (3). Two additional key indicators were also defined to reflect the maturity of the technology, bringing the total number of key indicators to 12. In addition to this, a set of secondary indicators in the above mentioned areas was defined, which includes 13 indicators. These secondary indicators could be used optionally, depending on the availability of data and the scope of the assessment.

Concerning the assessment method, the meeting recommended that:

- Comparative evaluations should be used either for a comparison of two technologies, or against a common basic case, to be well documented;
- Each comparative indicator should have a defined evaluation scale;
- A qualitative scale should be used only if there is sufficient data for quantified calculations; the use of ranges ("buckets") is an appropriate way to address uncertainty in quantified calculations;
- Where possible, scores for key indicators could be linked to ranges ("buckets") defined for the quantitative scale;
- Scoring scales, whether linked to ranges of quantified data or reflecting expert judgment should be kept as simple as possible. A '-1 – 0 – +1' scale is recommended for comparisons.

The outputs of this meeting will provide a basis for the discussion at yet another KIND preparatory meeting on advanced methods of expert judgment aggregation in May 2014, and at the technical meeting on KIND in July 2014. Some trial applications of the suggested key indicators and the assessment approach will test the feasibility of the approach, including methods to present the results. The outputs of the meetings will be reported to the INPRO Steering Committee in June 1014.

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Innovative Training on Nuclear Energy Sustainability

During the Spring Semester 2014, the INPRO Section provided online training sessions for IPNE students.

Three experts from the INPRO Section provided a series of lectures and workshops to students and faculty members of the Obninsk Institute for Nuclear Power Engineering (IPNE) of the National Research Nuclear University (MEPhI), Russian Federation, which focused on the analysis and assessment of the sustainability of nuclear energy systems. This activity was organized within the framework of a Practical Arrangement on education and training in the nuclear field, signed by the IAEA and MEPhI at the 56th IAEA General Conference.

The lectures covered: (1) an overview of INPRO's activities; (2) nuclear energy system analysis using the INPRO/GAINS analytical framework; and (3) findings of INPRO activities on small modular reactors, including transportable nuclear power plants. Using a web conferencing service proved to be an easy and effective way for providing the lectures and communicating with the audience. The lecture series was well received by all participants. Other Member States, such as e.g. Armenia, have already requested similar training activities in their countries.

INPE students attending an INPRO online lecture. (Photo: INPE)

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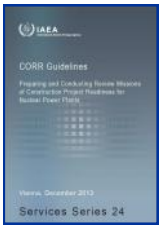
Recently Published

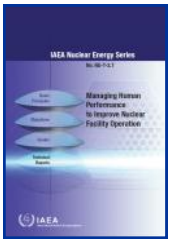
All IAEA publications can be downloaded for free at
http://www.iaea.org/Publications/

CORR Guidelines: Preparing and Conducting Review Missions of Construction Project Readiness for Nuclear Power Plants, SVS-24



A construction readiness review (CORR) mission for nuclear power plants has been established with the aim of conducting peer reviews of construction projects related to nuclear power plants. While the mission is applicable at any stage of an NPP construction project, two specific phases are targeted: the Phase 1 mission at start of construction and a Phase 2 in-progress mission (more on p. 4).

Managing Human Performance to Improve Nuclear Facility Operation, NG-T-2.7



Monitoring and improving human performance is one of the key challenges in the management of human resources for a nuclear facility. This report provides practical guidance and will assist Member States in reviewing and improving systems, as a major contribution to sustaining and improving the performance of nuclear facilities.

BN-600 MOX Core Benchmark Analysis: Results from Phases 4 & 6 of a CRP on Updated Codes and Methods to Reduce Calculational Uncertainties of the LMFR Reactivity Effects
IAEA-TECDOC-1700

The studies conducted in this CRP contributed to progress in development, verification and validation of new codes and data libraries for fast reactor analyses, and promoted deeper understanding of the influence of reactivity coefficients and their uncertainties on the results of experience and transient analyses in the initial phase of transients, such as unprotected loss of flow.

Operation and Licensing of Mixed Cores in Water Cooled Reactors (IAEA-TECDOC-1720)

The performance and operation of mixed cores is of interest to many nuclear power plants, as new and improved fuel designs have been introduced or a different fuel vendor has been chosen to supply fuel. This publication presents the outcome and results of two meeting held on these topics.

Evaluation of Advanced Thermohydraulic System Codes for Design and Safety Analysis of Integral Type Reactors, IAEA-TECDOC-1733

The IAEA organizes International Collaborative Standard Problems (ICSP) to facilitate the development and validation of computer codes for design and safety analysis of nuclear power plants. This publication presents the outcome of an ICSP assessing the capability of system thermal-hydraulic computer codes for integral reactor system design and safety analysis, which took place at the experimental facility at the Oregon State University, USA. The document also provides a description of the computer codes used and models developed .and includes lessons learned.

Inside the Division of Nuclear Power

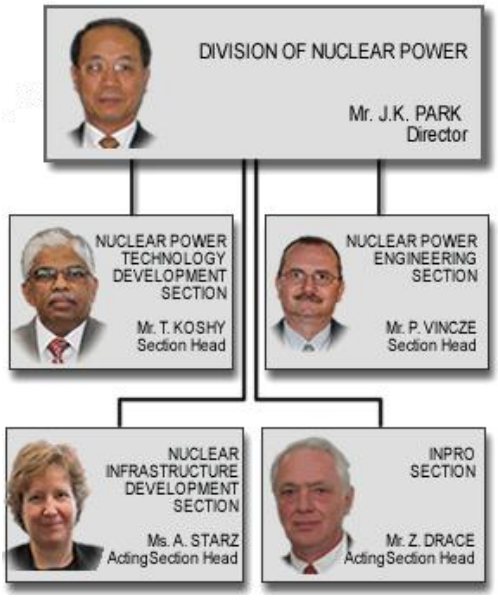
Improved Services for IAEA Member States: INIG and INPRO Group converted to Sections

IAEA Director General Yukiya Amano approved a new organizational structure for the Division of Nuclear Power in the Department of Nuclear Energy.

"The Agency has a comprehensive programme to assist Member States with established nuclear power programmes, as well as those building their first nuclear power plants," said Mr Amano in his introductory statement to the IAEA Board of Governors in Vienna on 3 March 2014. "The groups in the Agency responsible for supporting newcomers, and for the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), have been upgraded to Sections, which will help us to offer you improved services."

The **Integrated Nuclear Infrastructure Group (INIG)** has been converted into the **Nuclear Infrastructure Development Section (**NIDS**).** The new Section, led by Acting Section Head Anne Starz, supports Member States embarking on a new nuclear power programme or expanding an existing one, in building a sound nuclear infrastructure which is crucial to establishing and operating nuclear power programmes in a safe, secure and sustainable manner.

The INPRO Group has been converted into the **INPRO Section**. Led by Acting Section Head Zoran Drace, it supports the activities of the INPRO Project, which was established in 2000 to help ensure that nuclear energy is available to contribute to meeting the energy needs of the 21st century in a sustainable manner. INPRO's membership currently consists of 40 Members, i.e. 39 IAEA Member States and the European Commission.



New organizational structure of the IAEA Division of Nuclear Power

New on the Team

Lotta Halt, Training Specialist
Nuclear Power Engineering Section

Lotta Halt joined the Division of Nuclear Power as a Training Specialist from Sweden. She is supporting all aspects of human resource development and training in the area of nuclear power, and will contribute to further developing the IAEA e-learning series for nuclear newcomers. During her career of over 30 years, Lotta worked mainly at the Oskarshamn Nuclear Power Plant in Sweden, and during the past two years she was employed by the national Swedish Nuclear Safety and Training Company (KSU AB). Her area of expertise includes training for operation, maintenance, fire protection, industrial safety and radiation protection. She has an MSc in Education from Linnaeus University in Sweden.

Matthias Krause, Nuclear Engineer
Nuclear Power Technology Development Section

Matthias Krause joined the Division in February on a fixed-term contract from Canada. He is responsible for advanced technology developments in the area of Heavy Water Cooled Reactors (HWRs) as a team member of NPTDS. While born in, and still a citizen of, Germany, Matthias worked almost 25 years at Atomic Energy of Canada's two research laboratories, Whiteshell and Chalk River. His experience extends from high-temperature thermo-mechanical behaviour of CANDU core components to containment safety and severe accident issues, computer simulation, reactor safety analysis and thermalhydraulics, related to both power and research reactors. Before joining the IAEA, he managed AECL's Research Thermalhydraulics Branch and represented AECL and Canada on several national and international expert panels and writing groups.

Muhammad Zahid
Nuclear Power Engineering Section

Muhammad Zahid has joined the Division for one year as a cost-free expert from Pakistan. He will support activities on nuclear engineering instrumentation and control (I&C) and plant life management. Mr. Zahid has more than 12 years of experience in the nuclear industry and carried out information technology and I&C projects at the Pakistan Atomic Energy Commission. He holds a MSc in Computer Science from the University of Agriculture Faisalabad, Pakistan, and is a Certified Project Management Professional (PMP) from the US Project Management Institute. He also has a Certificate in Six Sigma (Black Belt) from the Singapore Quality Institute.

Upcoming Events: June to September 2014

All 2014 technical meetings organized by the Division of Nuclear Power at:
www.iaea.org/NuclearPower/Meetings/2014/

Date	Title	Location	Contact
10–11 June	Joint IAEA-GIF Technical Meeting/Workshop on Safety of Sodium-Cooled Fast Reactors	IAEA, Vienna, Austria	S.Monti@iaea.org
10–13 June	Technical Meeting on High-Temperature Qualification of High Temperature Gas Cooled Reactor Materials	IAEA, Vienna, Austria	F.Reitsma@iaea.org
17–20 June	Technical Meeting on INPRO's Collaborative Project on Nuclear Fuel and Fuel Cycle Analysis for Future Nuclear Energy Systems (FANES)	IAEA, Vienna, Austria	A.Grigoriev@iaea.org
24–26 June	Technical Meeting on Building a National Position on a New Nuclear Power Programme	IAEA, Vienna, Austria	M.C.Van-Sickle@iaea.org
24–27 June	22nd Meeting of the INPRO Steering Committee	IAEA, Vienna, Austria	Z.Drace@iaea.org
7–9 July	Technical Meeting on Severe Accident Mitigation through Improvements in Filtered Containment Venting for WCRs	IAEA, Vienna, Austria	C.Painter@iaea.org
7–9 July	Technical Meeting of the Technical Working Group on Nuclear Power Infrastructure	IAEA, Vienna, Austria	A.Starz@iaea.org
8–11 July	Technical Meeting on INPRO's Collaborative Project on Key Indicators for Innovative Nuclear Energy Systems (KIND)	IAEA, Vienna, Austria	V.Kuznetsov@iaea.org
22–24 July	Training Course on Water Management in Nuclear Power Plants	Bangkok, Thailand	I.Khamis@iaea.org
26–29 August	8th INPRO Dialogue Forum: Towards Nuclear Energy System Sustainability, Economics, Resource Availability and Institutional Arrangements	IAEA, Vienna, Austria	A.Korinny@iaea.org
2–5 September	Technical Meeting of the Technical Working Group on Managing Human Resources in the Field of Nuclear Energy	IAEA, Vienna, Austria	B.Molloy@iaea.org
4–5 September	Technical Meeting on the Status of the International Knowledge Base on Irradiated Nuclear Graphite Properties	IAEA, Vienna, Austria	F.Reitsma@iaea.org
8–12 September	Technical Meeting on Procurement Activities on Counterfeit, Fraudulent and Substandard Items: Experiences and Lessons Learned	IAEA, Vienna, Austria	J.H.Moore@iaea.org J.Boogaard@iaea.org
22–26 September	**58th IAEA General Conference**	**IAEA, Vienna, Austria**	
30 September–2 October	Technical Meeting on Hydromechanical Behaviour in Reactor Cores with a Plate-Type Fuel Assembly	IAEA, Vienna, Austria	M.Krause@iaea.org

Impressum

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