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Nuclear Power Newsletter

News from the Division of Nuclear Power
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The IAEA conducted an INIR mission in Turkey from 4 to 14 November 2013.

Nuclear Power Development in Turkey

An IAEA-led team of international experts reviewed Turkey's programme for introducing nuclear power and found that important progress has been made in the development of the country's nuclear infrastructure.

In November 2013, an Integrated Nuclear Infrastructure Review (INIR) mission, invited by the Government of Turkey, reviewed the country's progress in developing a national infrastructure for Turkey's new nuclear power programme. The INIR Mission team was led by Jong Kyun Park, Director of the IAEA Division of Nuclear Power, and consisted of IAEA staff from the Departments of Nuclear Energy, Nuclear Safety and Security, Safeguards and Technical Cooperation, the IAEA Office of Legal Affairs and international experts recruited by the IAEA in consultation with Turkey.

Turkey, which has considered nuclear power generation since the 1970s, decided to build nuclear power plants to meet the rapidly increasing demand for electricity and support the country's economic development. The share of nuclear power in Turkish electricity generation is aimed to reach at least 10 per cent by 2023.

In 2010, Turkey and the Russian Federation signed an agreement for the construction and operation of the first nuclear power plant at the Akkuyu site in southern Turkey, as a build-own-operate (BOO) project. The first of Akkuyu's four units, with a total capacity of 4800 MWe, is scheduled to be commissioned in 2021. A second nuclear power plant will be built at the Sinop site on the Black Sea, with Japan.

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Message from the Director

Welcome to the first issue of the Nuclear Power Newsletter for 2014. The 57th IAEA General Conference was held successfully in September 2013 with various events, including the exhibition of the Department of Nuclear Energy and three side events on nuclear power issues, i.e. 'Support to New Nuclear Power Programmes: INIR Missions and IAEA Assistance'; 'Third Nuclear Operator Organizations Cooperation Forum'; and 'Energy Planning and Nuclear Energy System Sustainability Assessment – Services of the Department of Energy', which was jointly organized with the Planning and Economic Studies Section. My sincere appreciation to the many participants who attended the events, and to our staff for their hard work!

Other major activities during the past few months included the Integrated Nuclear Infrastructure Review (INIR) mission to Turkey in November, the 21st INPRO Steering Committee Meeting in conjunction with the INPRO Dialogue Forum on Sustainability of Nuclear Energy System Based on Evolutionary Reactors, the 12th IAEA-FORATOM Workshop on Management Systems: Journey to Excellence in a Changing Environment, and interactions with international initiatives and organizations including the Generation IV International Forum (GIF) and OECD/NEA. These activities are described in more detail in this newsletter.

As of January 2014, the two Groups in the Division of Nuclear Power will be transformed into Sections: the Integrated Nuclear Infrastructure Group (INIG) will become the Nuclear Infrastructure Development Section (NIDS), and the INPRO Group will be turned into the INPRO Section.

We welcome three new colleagues: Mr Chad Lee Painter, a cost-free expert from the USA, and Mr Frederick Reitsma from South Africa have joined the Nuclear Power Technology Development Section (NPTDS), and Mr Tufan Yasar has joined the Division of Nuclear Power. We also had to say good bye and thank Mr Jong Ho Choi from NPTDS, who has returned to the Republic of Korea. We continue to provide opportunities for students and recent graduates within the IAEA's internship programme. By the end of 2013, 10 interns from seven Member States were able to gain practical experience in an international environment.

I wish all readers a peaceful and prosperous year 2014.

Jong Kyun Park
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"It is the first time in the history of nuclear power that the BOO approach is being used," said Mr Park. "This method is very interesting because it intends to solve two of the biggest challenges that newcomers face: financing and experienced operators."

Turkey and the IAEA agreed on a close cooperation in the development of the national nuclear infrastructure already a year ago, when the roadmap for the INIR mission was established during a meeting of IAEA and Turkish senior officials in November 2012.

This included IAEA assistance for the self-evaluation. "A pre-requisite for an INIR is a self-evaluation to be completed by the Member State", explained Anne Starz, Head of the IAEA Integrated Nuclear Infrastructure Group (INIG) and Scientific Secretary of the INIR Mission.

Some members of the INIR Mission Team and their Turkish counterparts (Photo: MENR)

During the two-week meetings, the review team worked closely with Turkish counterparts from the 25 organizations involved in building the national nuclear infrastructure, such as the Ministry of Energy and Natural Resources (MENR), which hosted the mission in Ankara, the Turkish Atomic Energy Authority (TAEK), which is the regulatory body, the Akkuyu Project Company, the national Electricity Generation Joint Stock Company EUAS, which will be in charge of the second nuclear power plant project, and other organizations.

Based on Turkey's Self-Evaluation Report, submitted to the IAEA earlier in 2013, the mission team reviewed in particular the development status of the infrastructure issues as defined in the IAEA's Milestones approach, identified areas that need further actions and provided recommendations and suggestions to Turkey regarding its infrastructure development. The experts noted that the programme enjoys strong government support and recognized several good practices, such as effective coordination among Government organizations, and the plan to establish a fund for future safety upgrades at the Akkuyu nuclear power plant. The mission's recommendations included further actions, such as completing a national policy on nuclear energy, strengthening the regulatory body, and developing a national plan for human resource development.

"The government of Turkey has established effective coordination mechanisms and has involved a large number of institutions that have a role in the establishment of the infrastructure needed to support the nuclear power programme," said INIR Mission Team Leader Mr Park. "Still, the country has more work to do to successfully implement the programme."

The IAEA will submit the final report to the Government of Turkey in early 2014. "The INIR Mission report will help us develop our national policy in nuclear energy, and our project company will help us in developing the requirements identified in the report," said Mr Metin Kilci, Undersecretary of the Ministry of Energy and Natural Resources.

This was the 12th INIR Mission organized by the IAEA since 2009. Other embarking countries have also benefited from this service, including Bangladesh, Belarus, Indonesia, Jordan, Poland, Thailand, the United Arab Emirates (UAE) and Vietnam. In early 2013, South Africa hosted an INIR Mission as the first operating country considering expansion of its nuclear power programme. Belarus, Poland and the UAE agreed to make their INIR reports available at: **www.iaea.org/NuclearPower/Infrastructure/INIR.html**

IAEA Milestones Approach

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

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

The Milestones approach is documented in the IAEA publication *Milestones in the Development of a National Infrastructure for Nuclear Power* (IAEA Nuclear Energy Series No. NG-G-3.1). This document is now revised to reflect experiences and lessons learned from its application in Member States, and will be published in 2014.

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More on...

Supporting Nuclear Infrastructure Development

New Online Products to Assist Nuclear Newcomers

As part of the implementation of the IAEA Action Plan on Nuclear Safety, the IAEA has developed two online products to assist Member States considering or embarking on a nuclear power programme: a Catalogue of Services for Nuclear Infrastructure Development and an Assistance Package for Future Owner/Operators.

IAEA Catalogue of Services

This online Catalogue integrates information about all available IAEA assistance, both existing and under development, into one convenient document so that Member States can easily identify and request the assistance necessary for national organizations at various stages of the implementation of a nuclear power programme. Such assistance includes training courses and workshops, advisory services, expert missions and other training tools and networks.

The Catalogue can also be used by countries that are expanding their existing nuclear power programmes.

Two versions of the Catalogue are available: one version is organized by Phases 1, 2 and 3 of nuclear infrastructure development as described in the IAEA 'Milestones' document, and the other is organized by the key organizations that are typically involved in the development of a nuclear power programme, such as government agencies and the Nuclear Energy Programme Implementing Organization (NEPIO), the regulatory body and the owner/operator.

The Catalogue is maintained by INIG in cooperation with other IAEA programmes and contains hyperlinks to webpages with information about each assistance activity. The Catalogue will be updated twice a year to ensure that it reflects any changes to IAEA assistance for Member States.

The **IAEA Catalogue of Services** is available at:
www.iaea.org/NuclearPower/Infrastructure/catalogue.html

or click on this button at:

www.iaea.org/NuclearPower/

Assistance Package for Future Owner/Operators

An assistance package for owner/operators, who are charged with the responsibility to implement the first nuclear power plant project, is focused on Phases 2 and 3 of the IAEA Milestones approach. It consists of three parts: workshops on owner/operator responsibilities, expert missions on the specific aspects of owner/operator activities, such as feasibility study, bid invitation specification, integrated management systems and others, and IAEA review services and missions.

The target audience for the assistance package is senior managers from NEPIOs or governmental agencies who are engaged in developing a national nuclear power programme, and managers and supervisors of future nuclear power plants.

The Assistance Package is available at:

www.iaea.org/NuclearPower/Infrastructure/Package-for-owner/index.html

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Fellowships for Nuclear Newcomers

IAEA fellowships are an excellent opportunity for young and promising professionals to broaden their knowledge and gain valuable experience through project-oriented on-the-job training.

Many fellowships are technically-oriented but when it comes to nuclear infrastructure development, a growing number of fellowships covers topics such as economics, legal matters, project management, human resource development, etc.

INIG works closely with the IAEA Department of Technical Cooperation (TC) to enable potential fellows from newcomer countries find the right host organizations in experienced countries and maximize the benefits of these fellowships. The interview with Ms Izabela Kulpa from Poland provides an example how a fellowship can help gain knowledge that would be difficult to acquire otherwise.

It takes time to set up a fellowship but this does not depend on the IAEA or the host institution alone. Those interested in applying for an IAEA fellowship can contribute by identifying the right host organization and thus speed up the process. Here are some tips for potential fellows:

- Take time to reflect on the work experience that would be most beneficial for you and your national project. Make sure it is relevant to your current work. Be as specific as possible and avoid subjects that are too broad.
- Identify potential host institutions that deal with the subject you are interested in. Establish direct contact with them and discuss what they would be able to offer to a fellow. This will help you select the most suitable host institution for your training.
- Include the name of that institution, along with the name of a contact person, in the application form. The form and more information on IAEA fellowships are available on the TC website at **www.iaea.org/technicalcooperation/How-to-take-part/As-Fellow-SV/index.html.** The application form must be submitted through official government channels.

In reviewing fellowship applications, the IAEA will consider the fellow's profile and the requested training to ensure they are compatible. The responsible IAEA officer will also contact the preferred institution and review the fellowship programme to be prepared by the host institution. The IAEA may suggest a change in the programme to ensure the fellowship will meet its goals. The IAEA will also provide financial support through TC funds. Fellows are encouraged to keep in touch with the IAEA after the fellowship, to help IAEA officers evaluate the usefulness of the training and monitor how fellows will implement the knowledge acquired in a national nuclear power programme.

Contact: Benoît Lepouzé, INIG; B.Lepouze@iaea.org

A Fellow's Experience

Izabela Kulpa *is a project manager at the Nuclear Energy Department of the Polish PGE Group, where she is in charge of human resources (HR) development and knowledge management for PGE's nuclear power project. She undertook an IAEA fellowship in October 2013 at CEA's Agence France Nucléaire International (AFNI).*

When did you apply and how did you find a host institution?

I first applied for a fellowship two years ago, and it took quite some time to determine my specific needs. The IAEA put me in contact with Mr Ponchet from CEA/AFNI, and we discussed over several months what I wanted to learn.

What did this fellowship bring to you and how can you make use of what you have learned?

The fellowship was very well prepared and every question I had was addressed by the relevant experts. The programme was so packed that even lunch time was used to review what I had learnt and adjust the programme, if necessary.

I was also able to work on an actual case to ensure that I had fully grasped the complexity of HR development for a nuclear power project. That exercise is still useful to me. I came back to Poland with concrete work examples and not just theoretical knowledge.

What's your advice for other IAEA fellows?

It's all about preparation. It takes a lot of personal involvement to define your needs and prepare your fellowship programme with a suitable host institution. But the time spent on preparation is not lost, it will make your fellowship all the more valuable.

One last remark?

I'm very thankful to both the IAEA and the CEA/AFNI for this experience. It has been incredibly useful. I wished it would have been longer but spending more time away from the office was not practical for me. I'd be interested in another fellowship in the future, this time in the UK, as they are in the same situation as my country.

Interview by Benoît Lepouzé, INIG

Join our Network for Nuclear Newcomers

A new 'Network for Nuclear Newcomers' on LinkedIn intends to raise awareness about ongoing efforts in Member States related to nuclear infrastructure, as well as create a platform for sharing lessons learned and good practices.

In numerous IAEA meetings, participants from Member States embarking on new nuclear programmes have expressed a need for greater networking opportunities. While each country may address each issue in a unique manner, many issues present common challenges to all countries, and therefore create opportunities for sharing experiences and lessons learned.

This is especially important because it has been nearly three decades since a 'newcomer' has started construction on its first nuclear power plant, and newcomer countries today are facing different challenges from countries that started such programmes in the 1970s and 1980s. Networks may also have a role in facilitating 'soft' coordination between newcomer countries and those countries providing support.

"We cannot underestimate the value of networking, of bringing together people and ideas to discuss common problems and identify practical solutions," said Jong Kyun Park, Director of the IAEA Division of Nuclear Power. "The development of strong networks is essential to our goal of building safe, secure and sustainable nuclear power programmes."

The IAEA conducted a Technical Meeting on "Establishing Networks for Countries Introducing Nuclear Power Programmes" in November 2013, which concluded that there was indeed a need for increased communication among newcomer countries. As a result, INIG has created a "Network for Nuclear Newcomers" through LinkedIn.

If you or your organization is interested in joining this LinkedIn group, please contact Matthew Van Sickle, INIG, m.c.van-sickle@iaea.org.

Annual Meeting on Nuclear Power Infrastructure Development

4-7 February 2014

The annual Technical Meeting on Topical Issues of Infrastructure Development is the main forum for senior managers involved in national nuclear power programmes to meet and discuss challenges and common issues.

Since first organized in 2006, the meeting has provided a useful opportunity to share good practices and lessons learned in establishing the required infrastructure for a safe and successful nuclear power programme.

The 2014 Meeting will continue this tradition. Targeted primarily at senior managers from national governments, future owner-operators, regulatory bodies or other institutions involved in the nuclear power programme, the meeting will focus on Member States challenges in prioritizing and sequencing activities that must be addressed in nuclear infrastructure development, as outlined in the IAEA Milestones publication. The meeting focuses on strategic management of new or expanding nuclear power development programmes, in particular on:

- National decision on nuclear power and pre-feasibility contents;
- Integrated approach to HR and workforce planning;
- Legislative and regulatory frameworks;
- Communication and stakeholder involvement;
- Preparing the national industry to be part of the nuclear power project;
- Contractual options, financing and managing financial risks.

More information at: **www.iaea.org/NuclearPower/Meetings/2014/2014-02-04-02-07-TM-INIG.html**

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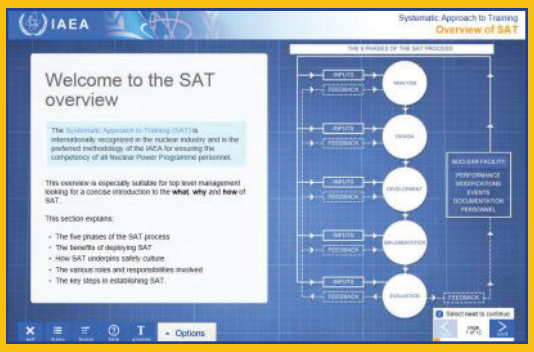
Two New Modules in E-learning Series for Nuclear Newcomers

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

The IAEA e-learning series on nuclear power infrastructure development has been extended by two new modules:



Module 6: Systematic Approach to Training (SAT) is internationally recognized as a key tool for ensuring the competency of all Nuclear Power Programme personnel.

Module 7: Feasibility Study represents an important step in the justification of a nuclear power plant new build project.

Nuclear Power Engineering

National Industry Involvement in Nuclear Power Programmes

When developing and implementing a strategy for national industry participation in a new or expanding nuclear power programme, there is no 'one-size-fits-all' approach.

A strategic supply chain and industrial involvement policy should be based realistically on a country's socio-economic situation and the size of its nuclear power programme. These were some of the findings of the technical meeting on *Strategic Supply Chains and National Industrial Involvement for Nuclear Power,* held in Beaune and at the Bugey Nuclear Power Plant, France, from 4−8 November 2013. The meeting was organized by the IAEA in cooperation with Électricité de France (EDF) in early November 2013.

"The supply chain for the construction of a first nuclear power plant includes partnerships between the owner/operator and its main suppliers," said Xiaoping Li from the IAEA Nuclear Power Engineering Section (NPES), who was one of the Scientific Secretaries of the meeting.

Planning and preparing for local industrial involvement, vendors' perspectives and considerations, and supply chains for operation, maintenance and waste management were the key topics discussed by some 60 experts from 26 IAEA Member States. While advanced newcomer countries shared their experience and concerns mainly about issues of national industry involvement, countries with operating nuclear power programmes focused on supply chain issues. Participants agreed that the owner/operator has the oversight of the project, since it is ultimately responsible for the safety of the nuclear power plant, as required by the nuclear regulator. "It is also important to figure out how to utilize the integrated management system and quality assurance system to qualify and select suppliers," said Masahiro Yagi from INIG and Co-Scientific Secretary of the meeting.

Participants at the AREVA heavy equipment manufacturing site. (Photo: EDF)

Thus the IAEA and meeting participants recommended that the owner/operator needs to be a 'knowledgeable customer' in order to ensure that the suppliers meet the established quality standards and the regulator's requirements for the manufacturing of structures, systems and components related to reactor safety. Once the plant is operational, the owner/operator will have the responsibility for the sustainability of the supply chains for long term operation. This applies to goods and services that are provided by domestic suppliers as well as those procured from foreign suppliers.

In addition to the meeting, the participants also enjoyed a technical tour to several French facilities that are supporting France's nuclear power supply chains.

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IAEA Training Course on Management Systems and Safety Culture

Gaining better knowledge and understanding of safety-focused management systems for new nuclear power projects, and developing a sound safety culture were the focus of an IAEA training course, held in collaboration with, and at the Argonne National Laboratory, USA.

Participants from 16 Member States, representing current and future owners/operators, regulators, suppliers and other organisations connected to nuclear facilities and activities learned how to establish management systems that meet the IAEA safety requirements, documented in the IAEA Safety Standards Series GS-R-3.

The training course also addressed the challenges faced during the implementation of a process-based management system, in which safety, security, quality, environmental and economic aspects are integrated, and discussed solutions how to overcome the challenges.

Lectures on integrated management systems and developing a safety culture were given by invited experts from Canada, Spain, and the USA and by IAEA staff. Practical exercises allowed the trainees to get hands-on training and gain a better understanding of the topics discussed. The course programme included basic processes for nuclear power programme management and the role and establishment of management systems; leadership and organizational culture; communication with stakeholders and using the management system to assure effective interaction between all involved parties; resource and process management; and using management systems to monitor, measure, assess and improve the organization, its processes, work and outcomes during all phases of the nuclear power plant project.

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Team building exercise at the IAEA Training Course at the Argonne National Laboratory, USA. (Photo:J. Roeschlova, IAEA)

IAEA/FORATOM: Journey to Excellence in a Changing Environment

A sustainable and successful management system for a nuclear facility ensures that nuclear safety matters are not dealt with in isolation. It integrates safety, health, security, quality assurance and environmental issues, as defined in the IAEA Safety Standards.

Some 125 senior managers and experts on management systems met at the IAEA on 20−22 November 2013 to discuss how to adapt their systems to ensure the safe management of nuclear facilities in a changing environment. Representing 32 IAEA Member States, they attended the **12th IAEA-FORATOM Workshop on Management Systems: Journey to Excellence in a Changing Environment.**

The series of workshops has been jointly organized by the IAEA and FORATOM since 1998, to raise awareness, increase understanding and promote the application of IAEA Safety Standards (GS-R-3, GS-G-3.1 and GS-G-3.5) for nuclear installations and activities.

As an international forum for the exchange of experiences, practical examples and case studies, the workshop focused on three key issues, relevant to the sustainability of an effective management system:

(1) Practical Solutions for the Integration of Elements in the Management System and Evaluation of its Performance;

(2) How to Improve a Management System in a Changing Environment, and

(3) Lessons Learned from an Emergency Situation.

"The nuclear sector is facing a changing environment," said Juan Carlos Lentijo, Director of the IAEA Division of Nuclear Fuel Cycle and Waste Technology during the opening session. "Many operational nuclear power plants have introduced or are planning to introduce life cycle extension programmes and flexible operational regimes. They may also have to face organizational changes due to corporate fusions or liberal market demands."

"Management systems for nuclear facilities should not be static," said Guy Parker, Senior Manager for Institutional Affairs at FORATOM. "They need to be continuously adapted to the changing internal and external environment".

Some changes have a major impact on how nuclear facilities should be safely managed. This may refer to regulatory oversight, security processes, integrating knowledge management or the development of a healthy safety culture in the management system. Other changes may raise even bigger challenges, such as adapting the management system when an operating company decides to construct a new nuclear power plant. "Performing a decommissioning project in parallel with continued operation of other facilities on the site is also a major challenge," explained Jan Van Looke, Chair of the Management Systems Task Force of FORATOM.

The detailed programme of the workshop and presentations are available at **www.mstf2013.org/**

Foratom, the European Atomic Forum, is the Brussels-based trade association for the nuclear energy industry in Europe. Representing 17 National Nuclear Associations, with almost 800 members from the European nuclear industry, FORATOM is a very important partner for the IAEA in the promotion and implementation of its Safety Standards and its Nuclear Energy Series documents. The longstanding cooperation between the IAEA and FORATOM was intensified by a Practical Arrangement signed in March 2012.

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Flexible Operation of NPPs

The majority of existing nuclear power plants (NPPs) is optimized to operate at steady, full power, known as 'base-load' operation.

However, recent rapid growth in the generating capacity of renewables, a large or growing percentage of the nuclear generating capacity, and deregulation of the public electricity supply system have necessitated flexible operations of NPPs including load following and frequency response.

"There are economic reasons and a need for simplicity for a nuclear power plant to operate 'base-load'. It is currently preferred by the operating organizations and the regulatory bodies", said Mr Jong Kyun Park, Director of the Division of Nuclear Power. "However, in a dynamic energy market, and within governments' energy policies and strategies, there has been an increasing need for plants to operate in 'flexible' modes".

These issues were addressed in an **IAEA Technical Meeting on Flexible (Non-Baseload) Operation Approaches for NPPs**, hosted by Électricité de France (EDF), in Paris in September 2013. More than 50 experts from 11 Member States with operating NPPs and five international organizations discussed the challenges of flexible operations and provided feedback to the IAEA's activities on providing guidance to the Member States. "The preferred option for nuclear operation is baseload since nuclear energy has high capital costs and low variable costs", said Henri Pelin of EDF. "However, flexible nuclear energy on a daily basis is safe and competitive if adequate design features and relevant training programmes are established".

The key aspects of safe, efficient and reliable flexible operations, including specific areas varying from design, economics, reactivity and fuel management, component ageing, to training, procedures and programmes as well as the nuclear and regulatory requirements were discussed during the three-day meeting. "The operating experience provided by French and German experts during the meeting gave us a very good understanding of the challenges and solutions for countries which are now implementing or considering non-baseload operation of their NPPs", said Ness Kilic from the NPES.

The experts concluded that, unless there is a need, the NPPs should operate baseload. However, NPPs should have the capabilities and capacities to implement flexible operations and be economically and commercially prepared, since the current trends in energy policies and electricity markets and portfolios indicate that such a need may arise sooner or later.

Since some Member States, both newcomers and expanding ones, are already seeking assistance with their implementation of load follow and/or frequency response in their NPPs, IAEA guidance will be useful.

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Baseload is the minimum amount of power that a utility or distribution company must make available to its customers, or the amount of power required to meet minimum demands based on reasonable expectations of customer requirements. Baseload values typically vary from hour to hour in most commercial and industrial areas. *(http://en.wikipedia.org/)*

Managing Material Degradation in NPPs

The demanding environments of an operating nuclear reactor may impact the ability of a broad range of materials to perform their intended function over extended service periods.

Identifying materials and components where degradation may occur is an important aspect of safe and secure operation of a nuclear power plant. "The global average operating time of a nuclear power plant is reached at 28 years," said Ki -Sig Kang, Technical Head for Plant Life Management and Long Term Operation, NPES. "However, many nuclear power plants would be able to operate safely beyond their initial design life".

To achieve this, each utility has to demonstrate that high levels of safety and security will be upheld for the extended service period by applying advanced ageing management techniques. Thus it is essential to understand the mechanisms of radiation damage to the system structure and components and possible mitigation approaches. These may include upgrading equipment and systems, monitoring, testing, incorporating experience feedback, as well as enhancing accident management procedures and human performance in light of the lessons learned from the Fukushima accident.

To address these issues, the IAEA has been convening technical meetings on material degradation for over 20 years. The 9th such meeting took place in November 2013 in Vienna. Over 80 experts from 29 Member States and the EC's Joint Research Centre came together to discuss current issues and future challenges of material degradation of system components of nuclear power plants.

The technical meeting was held at the IAEA on 5-8 November 2013. (Photo: K.S. Kang, IAEA)

The meeting provided participants with information on the degradation of ferritic and stainless steels in structures, systems and components. It also covered material degradation in light water and heavy water cooled reactors. The **IAEA Technical Meeting on Degradation of Primary System Components of Water Cooled Nuclear Power Plants: Current Issues and Future Challenges** was jointly organized by the IAEA's Department of Nuclear Energy and the Department of Nuclear Sciences and Applications.

More information and presentations are available at: **www.iaea.org/NuclearPower/Meetings/2013/2013-11-05-11-08-TM-NPE.html**

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Nuclear Power Technology Development

Supporting Fast Reactor Development and Deployment

This article summarizes recent IAEA achievements in the area of Fast Reactor (FR) technology.

Experts from eleven Member States participating in the IAEA Coordinated Research Project (CRP) on **Benchmark Analyses of an EBR-II Shutdown Heat Removal Test** presented first results from their simulations on how sodium cooled fast reactors (SFRs) would withstand a severe accident. The meeting was held at the IAEA on 5−7 November 2013.

The CRP, which started in 2012, provides an international framework for demonstrating inherent safety features of SFRs. "Evaluations of the passive safety capabilities of SFRs have acquired increased importance in the aftermath of the Fukushima accident", said Laural Briggs from the Argonne National Laboratory (ANL), USA, who chairs the CRP. Due to an enhanced focus on safety aspects, "the project provides opportunities for Member States to improve their safety analysis capabilities in the field of fast reactor simulation and design", underlined Stefano Monti, Scientific Secretary of the CRP and IAEA Team Leader for Fast Reactor Technology Development.

The EBR-II was a sodium-cooled fast reactor designed, built and operated by ANL. The shutdown heat removal tests performed in the reactor demonstrated the potential of SFRs to survive accidents more severe than the accident at the Fukushima-Daiichi nuclear power plant, with no core damage. These tests were also featured in the 2013 documentary film about the nuclear power debate, 'Pandora's Promise (**http://pandoraspromise.com**) , directed by Robert Stone.

The first research coordination meeting of the CRP on **Sodium Properties and Safe Operation of Experimental Facilities in Support of the Development and Deployment of Sodium-cooled Fast Reactors** was held at the IAEA on 12−14 November 2013. The CRP intends to harmonize sodium physical and chemical properties to be used in the design of innovative SFRs. It also addresses the need to develop design rules and best practices for sodium experimental facilities, as well as guidelines for the safe handling of sodium. The education and training of young engineers and scientists in the field of liquid metal coolants technology, even outside the nuclear field, is a complementary objective of the project. During the meeting, experts from ten participating Member States discussed and agreed on the structure, contents, methodology and work plan of the CRP. First results on the sodium properties are expected in 2014.

Among the broad range of activities in support of FR development and deployment, the preservation of the past knowledge is an indispensable basis for future projects and plays a central role at the IAEA. A recent initiative is developing advanced platforms for the storage, management and retrieval of the large number of documentation produced in designing, constructing, operating and decommissioning existing FRs.

The active participation of representatives from eight Member States and two international organizations at a technical meeting on the **Status of the IAEA Fast Reactor Knowledge Preservation Initiative** confirmed considerable interest in this activity. In particular, the participants will continue to contribute to the IAEA fast reactor knowledge preservation initiative, and potentially to the International Nuclear Information System (INIS) as well as to the powerful platform with advanced searching capabilities developed by the IAEA's Nuclear Knowledge Management Section.

The economics of FR is recognized as a key aspect in the future deployment of this technology. Experts from nine Member States and the OECD-NEA participated in a technical meeting on **Fast Reactors and Related Fuel Cycle Facilities with Improved Economic Characteristics**, held at the IAEA on 11–13 September 2013. The participants presented results of several studies on the economics of fast reactors and advanced fuel cycles. They also identified and discussed gaps that prevent an accurate estimate of FR and related fuel cycle costs. The meeting also discussed potential common strategies and alliances for the future development of prototypes and industrial demonstrators.

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

Experimental Breeder Reactor-II (EBR-II) at Argonne National Laboratory (Photo: Argonne, USA)

Participants in the Meeting on FR and Related Fuel Cycle Facilities with Improved Economic Characteristics. (Photo: IAEA)

Past and Future of High Temperature Gas-cooled Reactors

High Temperature Gas Cooled Reactors (HTGR) have been successfully operated in China, Germany, Japan, the UK and the USA. Research on HTGR technology has also been carried out in the Republic of Korea and in South Africa.

Some research reactors were running for more than 20 years, such as the AVR reactor, a prototype pebble bed reactor at the Juelich Research Centre in Germany, which was in operation between 1967−1988.

The current optimism in the industry is driven by presently operated research reactors in Japan (HTTR) and China (HTR-10), and by the construction of the demonstration power plant in China (HTR-PM) which is scheduled to start generating electricity by the end of 2017.

The modular HTR design, also used in the Chinese demonstration reactor, comes with exceptional safety features that exclude core meltdown and any large release of fission products. This makes emergency electricity generators or core catchers obsolete, since the reactor passively cools down by itself due to physical means. This is achieved through a low power density, an all graphite core structure with coated particle fuel, and a long slender design that allows effective decay heat loss, even if all the helium coolant is lost.

Other countries, such as India, are showing increasing interest in the technology, since it is feasible to use thorium as a fuel in HTGRs. The USA, for example, are interested in the use of HTGRs for supplying process heat to industries, for hydrogen production or using HTGRs for incineration or 'deep-burn' of spent nuclear fuel.

Latest developments in deep-burn options and concepts developed in Member States were discussed at an IAEA technical meeting. HTGRs have the ability to recycle, and therefore significantly reduce the nuclear waste produced today. Compared with presently dominant light water reactors, HTGRs show especially favourable characteristics with respect to plutonium incineration.

"HTGRs and coated particle fuel have the potential to incinerate large amounts of high level nuclear waste by using it as feed material", explains Frederik Reitsma, IAEA Team Leader for Gas Cooled Reactor Technology Development. This waste includes elements such as plutonium, neptunium and americium, summarized often as transuranic elements (TRU).

The high coolant temperature of HTGRs promises increased efficiency in electricity generation compared to the current commercial fleet of reactors. However, HTGRs have other useful applications beyond electricity generation, such as supplying heat at temperature ranges which cannot be achieved with the current commercial nuclear plants. This makes predictions about their future usage "challenging, but also exciting," said Mr Reitsma.

The meeting participants expressed their believe that the HTGR could be a bridging technology between current light water reactors operating in an open cycle and future fast reactors based on a highly fuel-efficient closed cycle which produce relatively small amounts of radioactive waste. High temperature reactors are not able to match fast reactors relying on a closed fuel cycle when it comes to fuel efficiency, but the technology is already mature and available today.

All presentations from the **IAEA Technical Meeting on Development of Deep Burn Concepts** are available at: **www.iaea.org/NuclearPower/Meetings/2013/2013-08-05-08-07-TM-NPTD.html**

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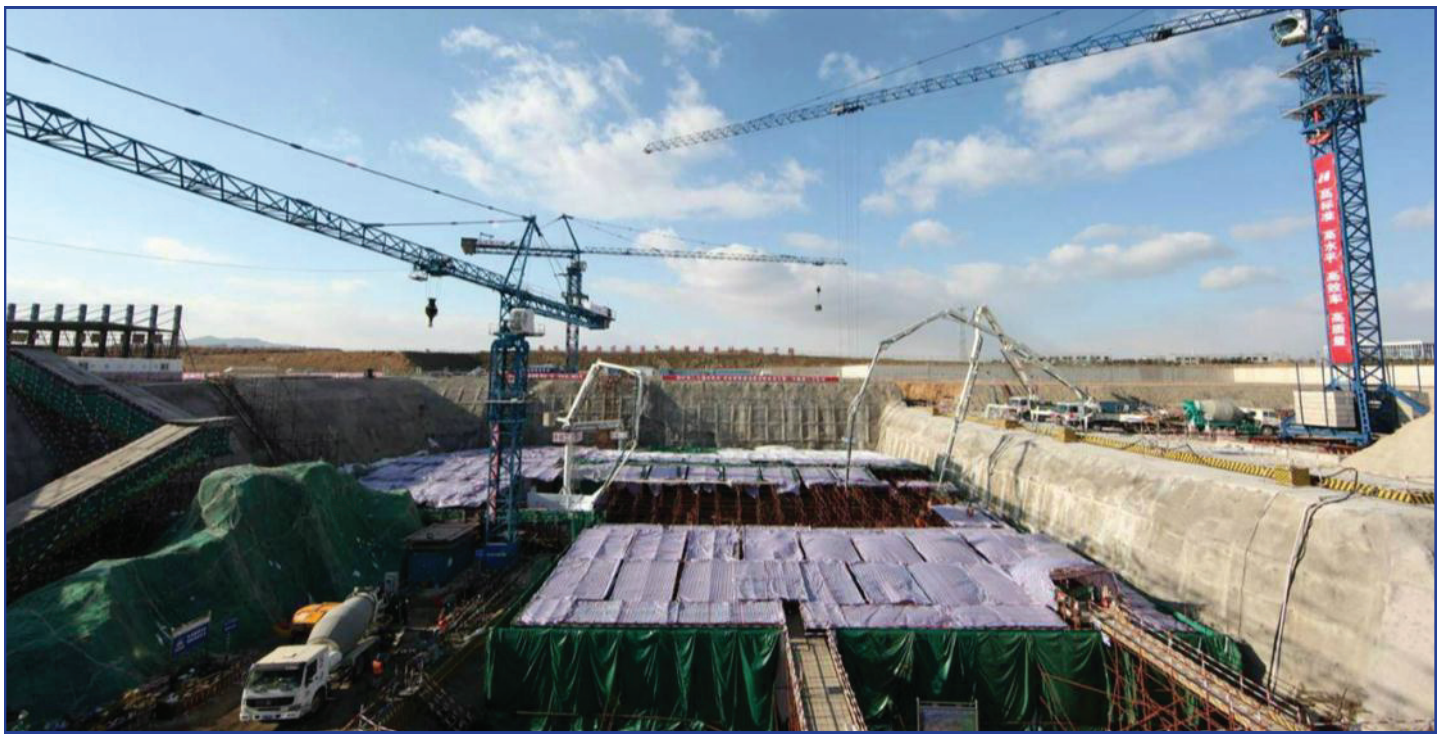

Currently under construction in east China's Shandong Province: the High Temperature Reactor – Pebble-bed Module (HTR-PM).

Evaluating Safety Design Criteria of High Temperature Gas-cooled Reactors

Safety design criteria are of prime importance to the licensing and operation of any nuclear reactor. A newly approved IAEA Coordinated Research Project (CRP) will focus on the safety design criteria specific to HTGRs.

Fourteen experts from seven Member States met at the IAEA at the end of October 2013 to exchange state-of-the-art information on the HTGR safety issues and prepared the CRP scope.

The IAEA Safety Standards reflect an international consensus on the safety of the predominantly used light water reactor technology. HTGR technology is in many ways significantly different. The safety of modular HTGRs is based on the inherent safety characteristics of the fuel and core design. The coated particle fuel contains the vast majority of all fission products even under the most severe postulated accidents where all coolant is lost. Safety demonstrations and evaluations show that no active systems are needed to fulfil the fundamental safety principles and that decay heat removal is achieved by all natural phenomena. This leads to a core design where meltdown is not possible.

Due to increased safety concerns, worldwide interest in HTGRs remains high and is manifested in the current construction of the High Temperature Reactor−Pebble-bed Module (HTR-PM) in China. As a result of their benevolent safety characteristics, HTGRs are regarded as future innovative reactor types although the technology is already available today, and past operating experience amounts to about 50 reactor years.

The reactors are also ideal for non-electrical applications due to the available high temperatures which gives them access to a huge potential market, for example in hydrogen production, coal gasification, etc., where the current nuclear reactor technologies cannot compete. Furthermore, HTGR designs do not require large amounts of water and can thus be built far from water resources and close to industrial areas that need energy.

Current HTGR designs are of small size (e.g. HTR-PM 211 MWe) compared to presently deployed large light water reactors (e.g. EPR 1600 MWe). This relatively small reactor size results in lower capital costs and shorter deployment times.

The CRP will evaluate past work on HTGR safety standards in countries that have operated HTGRs successfully, including Germany, the UK and the USA. Japan and China, which currently operate test reactors, will also participate. The work scope includes analysing the safety characteristics of different design approaches and should result in a list of qualitative, functional requirements, quantitative capabilities and quantitative reliabilities concerning HTGR safety.

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ICSP on Hydro-mechanical Behaviour of a Plate-type Fuel Assembly

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.

The implementation of ICSP usually includes an experimental investigation of interesting phenomena and simulation of the experiment with computer codes.

The IAEA recently initiated an ICSP on 'Prediction of Hydro -Mechanical Behavior in a Reactor Core with a Plate-type Fuel Assembly'. The purpose is to collect experimental data to assess the interaction of fuel plates (solid domain) under a range of flow rates (fluid domain), while maintaining a stable boundary pressure and fluid temperature in the reactor core, and to verify the suitability of using the prototype uranium-molybdenum alloy based fuel.

The ICSP will conduct an experiment to identify the flow conditions, which induce the onset of elastic plate deformation for fuel plates, and to identify the flow conditions which produce plate failure of each fuel plate material. The experiment will be conducted at the hydro-mechanical fuel test facility at Oregon State University (OSU), USA. The experimental data will be utilized to assess multi-physics tools simulating the following phenomena: flow disparity within a fuel plate assembly, bulk computational thermal hydraulic characteristics, influence of pressure boundary condition on the solid domain, and fuel plate plastic deformation and vibration.

The first meeting of ICSP participants was held at OSU in August 2013.Participants prepared a draft ICSP specification for pre-test calculation (blind calculation) and visited the test facility. Through the ICSP, participants should be able to identify any weakness or advantages of their prediction tools, search for ways to overcome any limitations, and also suggest further experiments or analytical models to fill any gaps identified in the ICSP.

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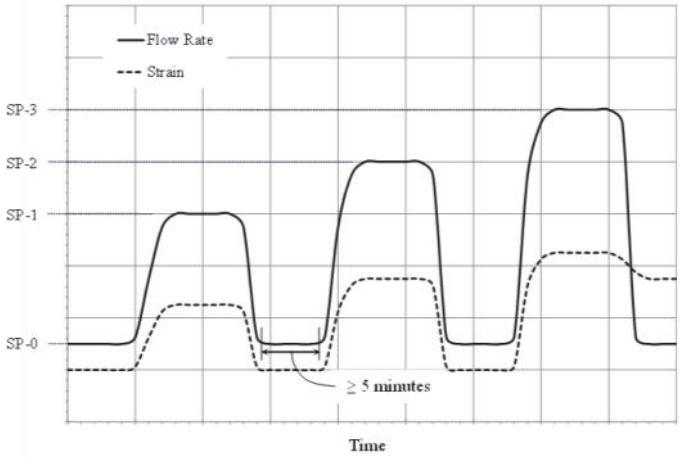

Sketch of bulk flow rate and plate strain versus time in plate failure tests.

New Version of ARIS Database Launched

*A new version of the IAEA's Advanced Reactor Information System (ARIS) database is now available at **https://aris.iaea.org**.*

ARIS is an ideal database for Member States considering their first nuclear power plant, or for those seeking to expand their existing programs by new construction. The database is a convenient, easy to use tool that provides detailed technical design descriptions for reactor plants that are in the design phase, under construction, or newly deployed. It includes reactors of all sizes and all reactor types, from evolutionary nuclear power plant designs for immediate deployment, to innovative reactor concepts still under development. The design descriptions included in the ARIS database are supplied by design organizations to the IAEA, where they are reviewed and edited to harmonize them into consistent, unbiased and easily searchable sets of data.

The database is complemented by the IAEA publication 'Nuclear Reactor Technology Assessment for Near Term Deployment' (IAEA Nuclear Energy Series No. NP-T-1.10). and a supplementary booklet on Status of Innovative Fast Reactor Designs and Concepts.

The ARIS database was designed and has been maintained by the IAEA's Nuclear Power Technology Development Section (NPTDS) since 2009.

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Nuclear Education on Water Cooled Reactors through Simulators

A workshop offered an overview of the design and operation associated with five types of water cooled reactors through the use of the various simulators for educational purposes.

Nuclear researchers, engineers, university professors, and nuclear regulators from eight Member States participated in the **Workshop on Physics and Technology of Water Cooled Reactors through the Use of PC-Based Simulators** organized by Spain's major simulator vendor, Tecnatom, in cooperation with the IAEA. The workshop was held at the company's facilities San Sebastian de los Reyes from 4−15 November 2013. The simulation software programmes were provided by the IAEA. Course modules were delivered by several instructors from Tecnatom, the Russian Federation and the USA.

The IAEA PC-based nuclear power plant simulators have been developed, and are distributed to Member States by the Nuclear Power Technology Development Section (NPTDS) for educational purposes. These simulators have been revealed as a powerful and very effective hands-on educational tool, providing an understanding of complex nuclear power plant system responses to normal and accident scenarios, reactivity control methods, and important plant safety features.

These workshops allow the IAEA to assist Member States in developing their human resources in the area of nuclear reactor technology. So far, 18 workshops were held in Egypt, Italy, the Republic of Korea, Saudi Arabia, Spain, the USA and at the IAEA.

More information about simulators and workshops at:
www.iaea.org/NuclearPower/Simulators/index.html

Contact: Katsumi Yamada and Chad Painter, both NPTDS;

Course participants working with simulation computer programmes (Photo: Tecnatom)

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

INPRO Steering Committee holds 21st Meeting

The INPRO Steering Committee consists of representatives from all INPRO Members, who meet regularly to review progress and provide guidance on future activities.

Every two years the INPRO Steering Committee discusses and endorses the INPRO Action Plan for the next biennium, which defines programme areas, detailed tasks and priorities for implementing INPRO's activities.

In November 2013, the Steering Committee held its 21st Meeting at the IAEA to hear about INPRO's recent progress and endorse the proposed INPRO Action Plan for 2014–2015. Pascal Anzieu from France chaired the meeting.

Alexander Bychkov, IAEA Deputy Director General for Nuclear Energy and INPRO Project Manager, highlighted recent key achievements including progress in ongoing Nuclear Energy System Assessments (NESAs) in Indonesia, Romania and Ukraine. "The NESA undertaken by Belarus was successfully completed and the report is published by the Agency, so that all IAEA Member States can benefit from its findings", said Mr Bychkov.

Several major publications were issued over the past few months, including the INPRO study on legal and institutional issues for transportable nuclear power plants and four reports on concluded INPRO collaborative projects, including the major GAINS report. "The revision and second edition of the INPRO methodology is well underway", said Mr Bychkov.

The INPRO Action Plan for 2014–2015 was first presented to the INPRO Steering Committee at its 20th meeting in May 2013, then revised based on comments from INPRO Members and presented again for endorsement at the 21st meeting. This Action Plan is described in detail in the following article.

Representatives of INPRO Members at the 21st Meeting of the INPRO Steering Committee, IAEA, 18 November 2013. (Photo: M.Gladyshev, IAEA)

"The new INPRO Action Plan places more emphasis on the integration of all activities under INPRO to provide practical decision making support to Member States in their national nuclear energy strategy development", said INPRO Group Head Zoran Drace. "The Action Plan is in full alignment with the Resolutions of the 57th IAEA General Conference; it is based on guidance from the INPRO Steering Committee and was developed in line with the INPRO Development Vision 2012–2017 and the IAEA's Programme and Budget for 2014 and 2015."

The Steering Committee tentatively endorsed the INPRO Action Plan 2014–2015, provided that comments made during the meeting will be addressed in the final version of the plan. The Committee agreed that INPRO could start implementing the new projects by developing terms of reference, organizing consultancies and reporting on the progress at the next meeting of the INPRO Steering Committee, scheduled for May 2014.

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INPRO Action Plan for 2014–2015

Under the new Action Plan, INPRO's activities will be organized in four Tasks, due to a new internal planning system, thus replacing previous 'Projects' on the same topics.

Four INPRO Tasks and New Activities

Task 1: Global scenarios (*former Project 2: Global nuclear energy scenarios*) develops global and regional nuclear energy scenarios, on the basis of scientific-technical analysis, that lead to a global vision of sustainable nuclear energy development in the 21st century.

The ongoing INPRO collaborative project (CP) on Synergetic Nuclear Energy Regional Group Interactions Evaluated for Sustainability (SYNERGIES) will be finalized in 2014 (see article on the 4th technical meeting, p. 15).

A new CP on Roadmaps for a Transition to Globally Sustainable Nuclear Energy Systems (ROADMAPS) will be launched in 2014. It will develop models of cooperation among countries and a template for documenting actions, scope of work, and timeframes by particular stakeholders for specific collaborative efforts.

The new CP on Key Indicators for Innovative Nuclear Energy Systems (KIND) will develop guidance on the evaluation of substantial improvements and risks in nuclear energy system performance potentially achievable with innovative nuclear technologies. The KIND CP will produce inputs for further improvement of the INPRO Methodology.

A new brochure will summarize the analytical framework developed by the concluded CP on Global Architecture of Innovative Nuclear Energy Systems (GAINS) to illustrate what can be achieved with its application.

Task 2: Innovations (*former Project 3: Innovations)* investigates innovations in selected nuclear energy technologies, related R&D and innovative institutional arrangements to support Member States in pursuing those innovations.

Two activities, started in 2013, will continue: dissemination of good practices in enhancing collaboration on innovations to support sustainable nuclear energy systems, and the INPRO CP on a review of innovative reactor core concepts for the prevention of severe accidents and mitigation of their consequences (RISC).

A new study on Transportable Nuclear Power Plants II (TNPP II) has been proposed, subject to sufficient interest in Member States, to examine in more detail legal and institutional issues for export deployment of a TNPP with a factory fuelled and tested reactor, and to investigate other aspects of transportable and modular NPPs.

A new CP on Nuclear Fuel and Fuel Cycle Analysis for future Nuclear Energy Systems (FANES) will focus on feasibility analyses of advanced and innovative fuels for different reactor systems and its influences on development of future NES. One of the primary challenges for developing the next generation of reactors and fuel cycles is to identify all problematic waste and find solutions well in time before the waste streams are expected to reach the end state.

A new CP on Waste from Innovative Types of Reactors and Fuel Cycles (WIRAF) will investigate optimal approaches for the management of such waste.

Task 3: Sustainability Assessment and Strategies (*former Project 1: National long-range nuclear energy strategies*) assists Member States in developing national long-range sustainable nuclear energy strategies and related deployment decision making through application of the INPRO Methodology.

Activities continued from the past biennium include producing a new edition of the INPRO Methodology as a set of ten NE Series documents, and providing practical assistance to countries in applying the INPRO Methodology in a Nuclear Energy System Assessment (NESA).

The CP on Proliferation Resistance and Safeguardability Assessment Tools (PROSA) will be concluded in 2014, providing recommendations for the assessment area of proliferation resistance in the INPRO Methodology.

The CP on Environmental Impact of Potential Accidental Releases from Nuclear Energy Systems (ENV-PE), which is developing a framework for a common understanding of the risk assessment of potential radiation doses released in accident scenarios will be concluded.

A new activity is the development of a concept for a service package to assist Member States with Nuclear Energy Systems Planning (NESP) by integrating the INPRO Methodology, NESA, national NES modelling and a dynamic analysis framework (developed under Global Scenarios).

A limited scope NESA of one or more sodium fast reactor detailed designs will be performed with participating technology holding Member States, to demonstrate the readiness of the INPRO Methodology to assess the sustainability of innovative reactors.

Task 4: Policy and Dialogue (*former Project 4: Policy and Dialogue*) provides an international venue for Member States' guidance, policy coordination and coordination with other international organizations and initiative, bringing together technology holders and users to share information on long-range nuclear energy system strategies, global nuclear energy scenarios and related technical and institutional innovations.

In 2014, the 8th and 9th INPRO Dialogue Forums will address an 'Update of the INPRO Methodology for Sustainability Assessment of Nuclear Energy System' (26−29 August 2014), and 'International Collaboration on Innovations: Towards Global Sustainable Nuclear Energy' (18−21 November 2014).

The full INPRO Action Plan 2014−2015 is available at **www.iaea.org/INPRO.**

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INPRO Dialogue Forum Discusses Evolutionary Reactor Designs

Experts from technology user countries and reactor engineers from the nuclear industry focussed on the sustainability of nuclear energy systems based on evolutionary reactors at the 7th INPRO Dialogue Forum, held at the IAEA on 19−22 November 2013.

Reactor engineers representing available evolutionary reactor products from AREVA (EPR), Candu Energy Inc. (EC6), GE Hitachi Nuclear Energy International (ABWR and ESBWR), KEPCO Engineering and Construction, KHNP (APR-1400), Mitsubishi (APWR) and ROSATOM (AES-2006) also participated. Juergen Kupitz from Germany chaired the forum.

"This Dialogue Forum is a unique and excellent opportunity for Member States to meet vendor experts and discuss issues related to sustainability of nuclear energy systems directly with them," said Alexander Bychkov, IAEA Deputy Director General and Head of the Department of Nuclear Energy, who is also the INPRO Project Manager.

Participants from the nuclear industry had voluntarily prepared detailed sustainability assessments of safety aspects of their reactor designs using the INPRO Methodology. Broad industry representation of seven detailed reactor designs and their safety assessments was an important step towards developing and promoting INPRO assessment services to Member States. The INPRO Methodology seeks to measure continuous improvements contributing to long term nuclear energy system sustainability. "It is not an evaluation of compliance with IAEA Safety Standards or Member State regulatory and licensing processes", explained Andriy Korinny, Scientific Secretary of the 7th INPRO Dialogue Forum.

Vendors provided detailed assessments to better familiarize Member States with the INPRO Methodology and to demonstrate its application to seven different evolutionary reactor products. They described technical safety improvements in the designs of their evolutionary reactors in comparison with their previous NPP designs, demonstrating how technical safety features fulfil INPRO acceptance limits. They also

Experts and engineers from 32 Member States focussed on the application of INPRO Methodology to evolutionary reactors at the 7th INPRO Dialogue Forum. (Photo: M. Gladyshev)

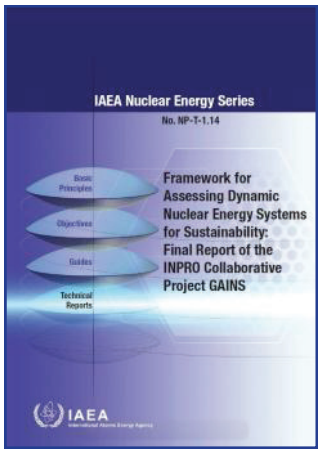
discussed additional safety features incorporated into their designs in response to lessons learned from the Fukushima accident. The important role of vendors in providing the necessary design information for a NESA was also discussed. Vendors agreed that for a full scope NESA, it would be efficient for a Member State assessor to work closely with vendors or with expert consultants fully knowledgeable of the design details.

The Member State participants suggested that INPRO should continue to organize similar forums with other assessment topics, involving vendor experts. One topic of particular interest is an INPRO sustainability assessment of nuclear waste management.

Related materials from the event are available at: **www.iaea.org/INPRO/7th_Dialogue_Forum/index.html.**

Contact: Jon R. Phillips and Andriy Korinny, both INPRO Group; J.R.Phillips@iaea.org and A.Korinny@iaea.org

INPRO's GAINS Report Published



The final report of the INPRO Collaborative Project on Global Architecture of Innovative Nuclear Energy Systems (GAINS) was released by the IAEA.

Entitled **'Framework for Assessing Dynamic Nuclear Energy Systems for Sustainability'**, this Nuclear Energy Series Report NP-T-1.14 presents the GAINS study, its results and conclusions drawn.

Available at the IAEA Publications website at:

www-pub.iaea.org/books/IAEABooks/8873/Framework-for-Assessing-Dynamic-Nuclear-Energy-Systems-for-Sustainability-Final-Report-of-the-INPRO-Collaborative-Project-GAINS

4th Technical Meeting of INPRO's SYNERGIES Project

The fourth technical meeting on INPRO collaborative project on Synergistic Nuclear Energy Regional Group Interactions Evaluated for Sustainability (SYNERGIES) was held on 18–22 November 2013 at the IAEA.

The SYNERGIES project started in June 2012 and since then held three technical and three consultants' meetings. Algeria, Argentina, Armenia, Belarus, Belgium, Canada, China, France, India, Indonesia, Italy, Japan, the Republic of Korea, Malaysia, Pakistan, Romania, the Russian Federation, Spain, Ukraine, the USA and Viet Nam are participants or observers in the different project tasks.

The SYNERGIES objectives are to apply and amend the analytical framework developed in the GAINS project to model more specifically the various forms of collaboration among countries, assess benefits and issues relevant for collaboration and identify those collaborative scenarios and architectures that ensure a 'win-win' strategy for both suppliers and users of peaceful nuclear energy technologies. The SYNERGIES project examines the drivers and impediments on a collaborative way to sustainable NES. The outputs of the project are expected to provide an important input for the development of comprehensive national nuclear energy strategies, taking into consideration possible international collaboration for transitioning to sustainable NES.

Twenty-three experts from 20 INPRO Member States and the UK (as an observer) presented and discussed the progress achieved since the third SYNERGIES meeting in June 2013. A detailed work plan and schedule for the period until the fifth SYNERGIES meeting in 2014 was developed and approved. Participants presented and discussed the deliverables produced according to the work plan and assigned responsibilities for preparation of deliverables for the final SYNERGIES report.

A brainstorming session was conducted to define the structure and content of the SYNERGIES report. This included updating the content table, identifying the deliverables to the SYNERGIES report, such as definition of the scope, responsibilities and deadlines for deliverables to be submitted to the IAEA, and a discussion on additional studies to be performed, including definition of the scope, responsibilities and deadlines for deliverables. It was also decided which of the initially considered studies that had made no progress, will not be pursued. In a writing session, inputs for the meeting report were produced.

The report will include chapters on:

- Synergies storylines and scenario 'families';
- Major finding of SYNERGIES scenario studies;
- Key indicators and economic assessment methods;
- Near and medium term actions to ensure long term sustainability of NES;
- Conclusion and recommendations;
- Annexes with contributions from Member States.

Participants in the 4th Technical Meeting of INPRO's SYNERGIES Project, held at the IAEA on 18–22 November 2013. (Photo: D. Simittchieva, IAEA)

At the time of the meeting, around 30 case studies have been or are being performed by project participants to be included in the final SYNERGIES report. Several draft deliverables were provided to the Secretariat during the meeting.

It was suggested that further INPRO activities on the development of tools for NES transition scenario analysis and assessment could benefit from a clearly defined strategy for the development of such tools and related data. The meeting participants also proposed that the INPRO Group could consider launching a cross-cutting study on legal and institutional issues of collaboration among countries in the nuclear fuel cycle back end. During the meeting, the US participant informed the meeting that the status of US participation in SYNERGIES was raised from observer to participant.

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Training Member States in Nuclear Energy Modelling

A Training Course on Evaluation of Collaborative Scenarios of Transition to Sustainable Nuclear Energy Systems using IAEA's Energy Model MESSAGE was held from 21 October to 1 November 2013 in Yogyakarta, Indonesia. It was jointly organized by the IAEA's INPRO Group and the Planning and Economic Studies Section (PESS).

The training course supported the INPRO activity on Global Nuclear Energy Scenarios, in particular modelling of scenarios of NES based on open and closed fuel cycles, viewed from a global perspective. Such modelling is being used in the INPRO Collaborative Project on SYNERGIES, and could also serve as a pre-requisite for later assessment of NES using the INPRO Methodology.

Thirty-three participants from Member States which participate in the SYNERGIES project and other countries attended the meeting. It provide training on the use of the IAEA's Model for Energy Supply System Alternatives and their General Environmental Impacts (MESSAGE) for evaluation of collaborative options for NES development within the framework of overall energy system analysis and planning.

Topics covered were: (1) Energy system planning and nuclear energy system modelling; (2) a detailed discussion of the MESSAGE methodology, modelling approach and functionality; and (3) training in the application of MESSAGE for modelling of specific technical and economic features of NES covering a once-through fuel cycle, closed-fuel cycle based on uranium and plutonium, and thorium fuel cycle for thermal and fast reactors.

MESSAGE can be used to model various options of NES and examine their feasibility, given all constraints and boundary conditions adopted in the model. MESSAGE plays a key role as a prerequisite for the performance of a NESA and the evaluation of innovative approaches in the global system.

The recent INPRO Collaborative Project GAINS made use of MESSAGE to craft a new model of innovative NES from the global perspective. This model takes into account differences in the countries' approaches to NES development and potential cooperation and multilateral solutions for the common global characters such as safety, resources and proliferation resistance. Several scenarios were analyzed including dynamic transition from the existing to future NES. The ongoing INPRO SYNERGIES project implements the GAINS framework and elaborates in greater detail the various forms of collaboration among countries, using MESSAGE inter alia for cost optimization.

Prior to the training course, a distance e-learning package was offered to all participants in order to develop basic skills on the use of the MESSAGE software for energy system modelling. As a result of the training, participants are able to use MESSAGE to model various NES including options on nuclear fuel cycle, denoting the country's approach toward potential cooperation and multilateral solutions. Participants developed 13 national case studies during the training and presented these case studies reflecting their efforts at the end of the meeting.

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Work Session during the Training Course (Photo: BATAN)

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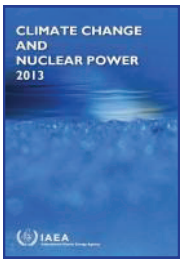
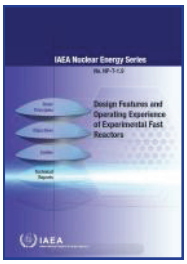


Climate Change and Nuclear Power 2013

CCANP-13

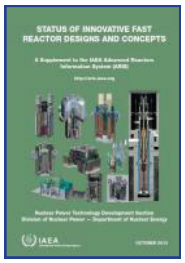
This report summarizes the potential role of nuclear power in mitigating global climate change and its contribution to other development and environmental challenges.



Design Features and Operating Experience of Experimental Fast Reactors

IAEA Nuclear Energy Series NP-T-1.9, STI/PUB/1585

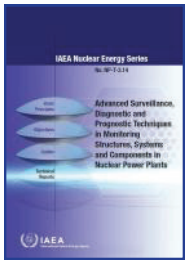
This publication compiles and documents significant aspects of fast reactor engineering development and experience.



Status of Innovative Fast Reactor Designs and Concepts

IAEA Booklet

This publication provides an overview of the status of innovative fast reactor designs and concepts and is a supplement to the IAEA Advanced Reactors Information System (ARIS).



Advanced Surveillance, Diagnostic and Prognostic Techniques in Monitoring Structures, Systems and Components in Nuclear Power Plants

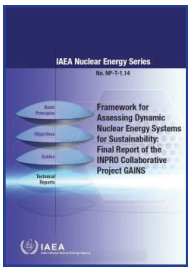
IAEA Nuclear Energy Series NP-T-3.14 , STI/PUB/1599

This publication reports on the work and findings of an IAEA CRP.

Benchmarking Severe Accident Computer Codes for Heavy Water Reactor Applications

IAEA-TECDOC-1727

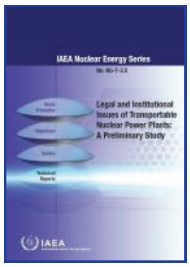
This document summarizes the results from a coordinated research project.



Framework for Assessing Dynamic Nuclear Energy Systems for Sustainability – Final Report of the INPRO Collaborative Project GAINS

IAEA Nuclear Energy Series NP-T-1.14, STI/PUB/1598

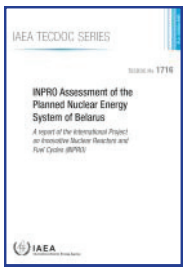
This report presents the GAINS study, its results and conclusions drawn.



Legal and Institutional Issues of Transportable Nuclear Power Plants: A Preliminary Study

IAEA Nuclear Energy Series NG-T-3.5, STI/PUB/1624

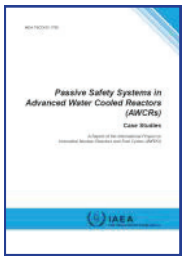
This publication highlights the potential benefits and challenges of transportable nuclear power plants.



INPRO Assessment of the Planned Nuclear Energy System of Belarus

IAEA-TECDOC-1716

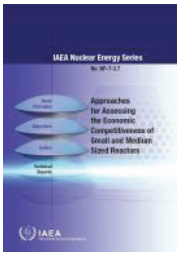
This report describes Belarus' assessment of their planned nuclear energy system using the INPRO methodology.



Passive Safety Systems in Advanced Water Cooled Reactors (AWCRs): Case Studies

IAEA-TECDOC-1705

This final report of the INPRO Collaborative Project on AWCR presents case study results on passive safety systems performed by Argentina, India and the Republic of Korea.



Approaches for Assessing the Economic Competitiveness of Small and Medium Sized Reactors

IAEA Nuclear Energy Series NP-T-3.7, STI/PUB/1619

This report will assist Member States in understanding the economic competitiveness of SMR technologies compared to other energy sources and large reactors.

New on the Team

Chad Painter, Senior Nuclear Engineer
Nuclear Power Technology Development Section

Chad Painter joined the Division as cost-free expert from the USA. He will assist in its collection, analysis, and technical cooperation related to advanced reactor technology. Mr Painter comes from the Pacific Northwest National Laboratory (PNNL), located in the U.S., where he managed a Reactor Materials and Mechanical Design group. His 30 year career as a nuclear professional has focused on reactor plant operations, nuclear fuel performance, materials fabrication development, MOX fuel development, and irradiation test planning and execution in several research reactors around the world, e.g. ATR, JOYO, and Halden.

Frederik Reitsma, Nuclear Engineer
Nuclear Power Technology Development Section

Frederik Reitsma has joined the IAEA on a short term contract from South Africa. He is responsible for the area of gas cooled reactor technology focusing on High Temperature Reactors (HTRs). During his career, he worked at Necsa, the South African national nuclear laboratory and held several senior positions at the South African PBMR company. In the past few years, he also ran his own consultancy company. His expertise is on core neutronic design and safety of high temperature reactors. He also has a keen interest in research reactors and reactor physics methods development. He has an MSc in reactor science from the North West University and is completing his PhD at RWTH Aachen University in Germany.

Tufan Yasar, Nuclear Information Specialist
Division of Nuclear Power

Tufan Yasar has joined the Nuclear Power Division as a Nuclear Information Specialist where he will support and enhance the effectiveness of collaboration in nuclear reactor technology development amongst Agency staff and experts in Member States. He will coordinate the Division's IT needs with centralized IT support. He will be also responsible for several databases and their web sites. Mr Yasar comes from Siemens, located in Germany, where he worked as an Instrumentation and Control Engineer for Nuclear Power Plants for seven years.

Communication

Follow us on Twitter!

@IAEANE

The IAEA Department of Nuclear Energy created a twitter account in 2012. The number of our followers has quadrupled in 2013 and has reached 664 at the time of the editing of this newsletter.

We tweet about news stories ranging from uranium mining to operation of NPPs, from climate change and nuclear power to advanced reactors, waste management, decommissioning and environmental remediation, as well as photos, meetings, publications, job openings and more.

Follow the NE Twitter account @IAEANE at **twitter.com/IAEANE**

Your retweets and comments are welcome.

Nuclear Energy News App: Gateway to Nuclear Energy Information

The IAEA Department of Nuclear Energy has created a mobile application ('app') , named **NE News** that allows users to access all the Department's newsletters, brochures and social media channels through a single portal. This includes the authoritative IAEA Nuclear Energy Series of technical publications, which covers a wealth of topics, ranging from introducing nuclear power to decommissioning.

The NE News app is available for iPad and iPhone, as well as now for Android devices from the Goggle store.

The free-to-use app was designed and developed by the Department's Nuclear Information Section.

NE News App (Photo: D. Calma, IAEA)

Upcoming Events: January to May 2014

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

Date	Title	Location	Contact
4–7 Feb	Technical Meeting on Topical Issues in the Development of Nuclear Power Infrastructure	IAEA, Vienna, Austria	M.Ferrari@iaea.org
18–21 Feb	Factors that Can Influence Safety and Security Culture in the Development of a National Nuclear Power Programme	IAEA, Vienna Austria	B.Molloy@iaea.org
4–6 March	8th INPRO-GIF Interface Meeting	IAEA, Vienna Austria	J.Phillips@iaea.org
17–21 March	Workshop on Energy Assessments and Pre-Feasibility/ Feasibility Studies for a Nuclear Power Programme	Seoul, Republic of Korea	K-S.Kang@iaea.org
25–26 March	Technical Meeting for Users of the Hydrogen Economic Evaluation Programme (HEEP)	IAEA, Vienna, Austria	I.Khamis@iaea.org
7–11 April	Technical Meeting on Becoming a Knowledgeable Customer within the Framework of a Nuclear Power Programme	Moscow, Russian Federation	B.Lepouze@iaea.org
8–11 April	Technical Meeting on the Safety of High Temperature Gas-cooled Reactors in the Light of the Fukushima Daiichi Accident	IAEA, Vienna, Austria	F.Reitsma@iaea.org
8–11 April	Technical Meeting of Effective Collaboration in Innovations to Support Sustainable Nuclear Energy Systems	IAEA, Vienna, Austria	A.Grigoriev@iaea.org A.Kazennov@iaea.org
14–16 April	Technical Meeting on Priorities in Modelling and Simulation for Fast Neutron Systems	IAEA, Vienna, Austria	S.Monti@iaea.org
28–30 April	Technical Meeting on the Construction and Commissioning of Fast Reactors	Kalpakkam, India	S.Monti@iaea.org
12–16 May	International Conference on Human Resources Development for Nuclear Power Programmes: Building and Sustaining Capacity	IAEA, Vienna, Austria	B.Molloy@iaea.org S.Mallick@iaea.org
12–16 May	Technical Meeting on Operating Fundamentals of Pressurized Water Small and Medium Sized Reactors	Islamabad, Pakistan	H.Subki@iaea.org
19–23 May	47th Meeting of the Technical Working Group on Fast Reactors	IAEA, Vienna, Austria	S.Monti@iaea.org
19–23 May	Technical Meeting on Utilization of PC-based Nuclear Power Plant Simulators for Education	IAEA, Vienna, Austria	K.Yamada@iaea.org
20–23 May	Technical Meeting of the INPRO Collaborative Project on Waste from Innovative Types of Reactors and Fuel Cycles (WIRAF)	IAEA, Vienna Austria	Z.Drace@iaea.org A.Grigoriev@iaea.org
26–27 May	Technical Meeting for Users of the Hydrogen Economic Evaluation Programme (HEEP)	IAEA, Vienna, Austria	I.Khamis@iaea.org

Impressum

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