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Division of Nuclear Power
Department of Nuclear Energy, IAEA
PO Box 100, Vienna International Centre
1400 Vienna, Austria
Tel : +43 1 2600 25718
Fax: +43 1 2600 –7
Email: E.Dyck@iaea.org

Photo: Jérémie Croidieu

International Conference on Fast Reactors and Related Fuel Cycles: Safe Technologies and Sustainable Scenarios

The world's fast reactor community met in Paris in March 2013 to explore new opportunities in the development of fast reactor and related fuel cycles.

Fast reactor technology has the potential to ensure that energy resources, which would run out in a few hundred years using today's technology, will actually last several thousand years. Fast reactors also reduce the volume and toxicity of the final waste. The IAEA has been supporting fast reactors technology and providing a forum for international cooperation.

The most important event dedicated to this technology is the International Conference on Fast Reactors and Related Fuel Cycles organized by the IAEA and held every four years since 2009, when Japan hosted the conference in Kyoto (FR09).

Four years later, almost 700 experts from 34 countries and 3 international organizations gathered in Paris on 4–7 March 2013 for the **International Conference on Fast Reactors and Related Fuel Cycles: Safe Technologies and Sustainable Scenarios** (**FR13)**.

"The IAEA remains the unique collaboration forum for ensuring continued progress in fast reactor technology", said IAEA Director General Yukiya Amano in a video opening address.

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Message from the Director

The 11th of March marked the second anniversary of the tragic accident at the Fukushima Daiichi nuclear power plant in Japan. The IAEA has made significant efforts to help Japan deal with the consequences of this accident and the Division of Nuclear Power (NENP) played an important part in all related IAEA activities, such as the implementation of the IAEA Action Plan for Nuclear Safety, International Experts Meetings and peer reviews during the past two years.

Since the beginning of the year, we have had a busy time with many ongoing projects and meetings on different aspects of nuclear power. One major activity was the International Conference on Fast Reactors and Related Fuel Cycles: Safe Technologies and Sustainable Scenarios (FR13) held in Paris in March 2013. Its main purpose was to provide a forum for exchange of information on national and international programmes, new developments and experiences in the field of fast reactors and related fuel cycle technologies. Another major activity was the Integrated Nuclear Infrastructure Review (INIR) mission to South Africa conducted from 30 January to 8 February 2013. It was the first INIR mission to a Member State which has operating nuclear power plants. An INIR Mission to Poland was conducted for Phase 1 of the IAEA Milestones approach in March 2013.

The first Divisional retreat in 2013 was held on 15 February, and the main topic was 'communication'. Sixteen staff from NENP joined the retreat including Heads of Sections and Groups. Among the issues discussed were early planning and coordination of activities, websites improvement, divisional seminars to share information and enhance communication, and a review of structural changes of the two Groups, INIG and INPRO, in the Division.

We welcome two cost-free experts from the Russian Federation in the INPRO Group, Ms Galina Fesenko and Mr Alexey Grigoriev.

In this issue, several colleagues will introduce their home towns: Ms Elisabeth Dyck presents the small town of Perchtoldsdorf near Vienna, Austria; Mr Roy George introduces Thodupuzha in India; Ms Miriam Kim Park writes about the Canary island of Tenerife, Spain, and Mr Antonio Toti introduces Terracina in Italy.

I extend my best wishes to all readers of this newsletter.

Jong Kyun Park
J.Park@iaea.org

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"We provide an umbrella for knowledge preservation, information exchange and collaborative R&D in which resources and expertise are pooled", Mr Amano added.

"Promising innovation routes are now clearly identified to further enhance safety, reduce capital cost and improve efficiency, reliability and operability, making the Generation IV sodium fast reactor concept an attractive option for electricity production", said Laurent Michel, Director General, French Ministry of Ecology, Sustainable Development and Energy, in his opening remarks.

Main advances in the key areas of technological development were presented during the 41 technical sessions of the conference, including advances in fast reactors and fuel cycles technology, safety, and economic and proliferation resistance related issues.

The conference also identified gaps and key issues that need to be addressed in the industrial-scale introduction of fast reactors, including public acceptance. Several existing fast reactors, current construction projects, and innovative fast reactors concepts under development at the national level and by international initiatives were reviewed and discussed.

"Since the 2009 conference, the fast reactor community has achieved very promising results in the field of Generation IV safety design criteria, prevention and mitigation of severe accidents, advanced steam generators and power conversion systems, low swelling steels for fuel cladding, multi-physics coupling and high performance computing", summarized Christophe Behar, Director of Nuclear Energy at CEA and Chairperson of the Conference.

Safety and Sustainability

In line with this year's focus on safety and sustainability, two panels were devoted to the safety of innovative fast neutron systems and to the sustainability of the related fuel cycles.

FR 13 in Numbers

700 Participants from
34 Member States and
3 International Organizations
4 Plenary Sessions and 2 Panels
10 Tracks and 41 Technical Sessions
381 papers from 26 countries
223 Presentations
2 Poster Sessions and 158 Posters
1 Young Generation's Event

Panel on Safety Design Criteria (SDC). The first panel, chaired by Peter Lyons, Assistant Secretary for Nuclear Energy in the US Department of Energy, discussed various considerations related to SDC currently being developed at the international level. A common theme was that there needs to be a clear differentiation between the criteria for Generation III reactors and Generation IV reactors to demonstrate that safety is being improved in Generation IV systems. Other common themes were that SDC are very important for both the designer and regulator, and a dialog between the two is necessary to reach a common understanding. While the safety principles should be common, the technology specific SDC should consider the unique aspects of the fast reactor, including coolant, fuel, fuel assembly geometry and others. The SDC need to address both accident prevention and consequence mitigation. They need to include lessons learned from the Fukushima accident, especially criteria related to complete loss of electrical power, loss of heat sink, and the design basis for external events.

Panel on Sustainability of Nuclear Energy. The second panel, chaired by Ron Cameron, Head of the Nuclear Development Division at OECD/NEA, discussed sustainability in terms of social, environmental and economic perspectives. The panelists from six Member States, the EC and the IAEA presented their perspectives of the need to move towards a sustainable future, involving better use of uranium, reductions in high-level radioactive waste, and safe, secure and economic operation of nuclear reactors and the fuel cycle. In all cases, it was considered that in the long term, sustainability must involve fast reactors and a closed nuclear fuel cycle, although these are national decisions and there will be no single solution for all countries. Continued research is needed on the technologies that will support a full recycling process and international cooperation remains a primary means by which progress can be achieved.

Young Generation's Event (YGE)

This event offered a great opportunity for young academics and professionals to present their ideas, work and visions to experts in this innovative and exciting area of nuclear technology.

Panelists at the Young Generation's Event. (Photo: Jérémie Croidieu)

Christophe Béhar, Director of Nuclear Energy at CEA and Chair of the FR13 Conference. (Photo: Jérémie Croidieu)

Prior to the conference, the IAEA had launched a video contest on YouTube. Young academics and professionals under the age of 35 were invited to submit a brief video introducing a project, a paper or simply innovative ideas in the field of fast reactors and related fuel cycles. From all submissions, five exceptional videos from France, Germany, Japan and the Russian Federation (2) were selected and their producers were invited to participate in the conference.

The YGE was organized in two parts: during a workshop, the young professionals elaborated definitions, current challenges and interlinking synergies for six topics, including sustainability, innovation, simulation, safety, economics and public acceptance.

At the main YGE, 150 people listened to the ideas and visions of the young generation. Edouard Hourcade from CEA moderated a panel discussion set up as a 'medical emergency scenario'. Under the motto "Mr. Earth has unresolved sustainability problems: a team of young experts tries to find a solution", the six nominated spokespersons tried to jointly find acceptable solutions to assure sustainability and energy supply for the future. The panel discussion reflected the widespread awareness of young people of technology development, safety aspects, economic dependency and environmental responsibility.

"The Young Generation's Event gave a very strong signal from our future experts that fast reactors and related fuels cycles are a technology for the future", said Stefano Monti, Scientific Secretary of FR13 and Team Leader for Fast Reactor Technology Development in the IAEA Nuclear Power Technology Development Section.

Next Conference—FR17

FR13 was a successful event which acted as a catalyst for further collaborations and alliances for fast reactors development programmes. The conference was organized by the IAEA and hosted by the Government of France through CEA (*Commissariat à l'énergie atomique et aux énergies alternatives)* and SFEN, the French Nuclear Energy Society, in cooperation with the OECD's Nuclear Energy Agency (OECD/NEA). The next conference, FR17, will be held in the Russian Federation in 2017.

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

More on… Nuclear Power Technology Development

GIF/IAEA: Safety Design Criteria for Sodium Cooled Fast Reactors

The Generation IV International Forum (GIF) and the IAEA held their third workshop since 2010, which focused on safety design criteria for Sodium Cooled Fast Reactors (SFRs), and the harmonization of safety approach, safety requirements and design criteria for GEN-IV SFRs under development worldwide.

More than 30 experts from China, France, Germany, India, Japan, the Republic of Korea, the Russian Federation, the USA, the European Commission (EC), the OECD/NEA, GIF and the IAEA met in Vienna on 26–27 February 2013. This third workshop also involved representatives of regulatory bodies and technical support organizations. The first joint meeting in June 2010 covered operating experience and safety fundamental of SFR designs, while the second workshop, in November 2011, focused on lessons learned from the Fukushima Daiichi accident and safety implications for the design of innovative SFRs.

“This Workshop represented a fundamental milestone in the close collaboration between GIF and the IAEA in the field of safety of sodium-cooled fast reactors”, said Jong Kyun Park, Director of the IAEA Division of Nuclear Power.

The workshop is also timely as the IAEA has started to review the applicability of its Safety Requirements for ‘Design of nuclear power plants’ and for ‘Safety assessment for facilities and activities’ to advanced reactors designs, particularly for innovative SFRs. “A GIF Task Force has been formulating safety design criteria for SFR over the past two years”, explained Yutaka Sagayama, Vice-Chair of GIF. “This workshop has provided a valuable opportunity to present and review them”.

The meeting confirmed the need to develop safety design criteria for innovative GEN-IV SFRs which should be harmonized, to the maximum extent possible, at the international level. It was also suggested that the criteria become part of the IAEA recommendations within the set of Safety Requirements for innovative SFRs. Safety design concepts of SFRs that are being developed in Member States were also presented and discussed, with an emphasis on design measures against Design Basis Accidents (DBA) and Design Extended Conditions (DEC), as well as associated safety evaluations and supporting R&D.

“We were able to report on two years of work on the safety design criteria. I think it clarified for many of us that the Criteria that have been developed are for designers as well as for regulators”, said Harold McFarlane, Technical Director of GIF, who chaired the workshop. “We were also able to hear about the Standard being developed by the American Nuclear Society, which is more intended to assist the regulator in terms of eventually licencing one of these sodium fast reactors. I think we are starting to see convergence on the safety expectations for a fourth generation sodium fast reactor”.

The main outcomes of the workshop were discussed at the 7th GIF-IAEA/INPRO Interface Meeting, on 28 February–1 March 2013 at the IAEA (see p. 14) and presented during the Panel on ‘Safety Design Criteria’ (see p. 3) at the FR13 Conference in Paris in March 2013.

The 4th GIF/IAEA Workshop on Safety of SFR will be held in 2014 and address the safety guides to be elaborated after consolidating the safety design criteria discussed at the 2013 meeting. It will involve the designers of innovative SFRs under development worldwide.

Contacts: Stefano Monti, NPTDS; S.Monti@iaea.org;
Jon Phillips, INPRO; J.R.Phillips@iaea.org

International and IAEA experts discussed safety design criteria of SFRs at a GIF/IAEA Workshop in February 2013.

IAEA Technical Working Group on Gas Cooled Reactors

Technical Working Groups (TWGs) are groups of experts, nominated by their governments, who provide advice and support for the implementation of various IAEA programmes. They represent a global network of excellence and expertise.

The TWG on Gas Cooled Reactors (GCR) met at the IAEA on 5−7 March 2013 to review national and international high temperature gas cooled reactor (HTGR) programmes and learn about, and advise the IAEA on, its GCR activities.

China: Construction of the 200 MWth Generation IV Shidaowan demonstration high-temperature pebble bed modular nuclear reactor (HTR-PM) started in December 2012 when the first concrete was poured. Plant engineering, verification and testing, equipment procurement, component manufacturing and construction work are ongoing. The HTR-PM plant in east China's Shandong Province is expected to go into operation at the end of 2017.

Japan: In response to the accident at the Fukushima Daiichi nuclear power plant, the Japan Atomic Energy Agency is designing a naturally safe HTGR (NSHTR) based on inherent safety features and a clean burn HTGR for burning surplus Plutonium in Japan. The NSHTR ensures safety based on the natural phenomena of the reactor without relying on active and passive safety systems. It is expected that this system would be accepted by the general public, even after the Fukushima Daiichi accident.

Indonesia: A Presidential Regulation mandates the National Nuclear Energy Agency of Indonesia (BATAN) to develop a conceptual design for an advanced power reactor based on high temperature GCR technology, suitable for future deployment on the Java-Madura-Bali Islands. Research activities on the conceptual design of the system of the advanced power reactor for cogeneration include the conceptual design of a 200 MWth reactor core and power conversion system with cogeneration of process heat for hydrogen production and desalination processes.

South Africa: The PBMR Company still exists as an entity and will be maintained until a government decision is made. Its activities to care and maintain the intellectual property have largely been completed, and the most important data have been packaged and captured. The main test facilities (fuel development laboratory and helium test facility) are in care and maintenance. There is a new initiative by a private company, Steenkampskraal Thorium Limited (STL), to work on the design of the TH-100, a 35 MWe (100 MWth) pebble bed generator. The TH-100 is an HTGR that may include a thorium-based fuel cycle.

USA: Activities are being pursued in the areas of TRISO fuel qualification, graphite and high temperature metals development, computational methods development, and licensing framework development. Post-irradiation examination (PIE) of laboratory manufactured fuel is demonstrating excellent performance and will be completed in 2014. Design and safety methods validation experiments are being carried out, including construction and testing at the High Temperature Test Facility, an electrically heated ¼ scale reactor vessel which will be used to simulate conduction cool-down transients. The Next Generation Nuclear Plant (NGNP) project has recently entered into a one-year contract with industry to perform economic analysis regarding commercializing HTGRs and to provide data that will inform R&D decisions of the US Department of Energy.

TWG-GCR members at the IAEA in March 2013.

The TWG-GCR also discussed the implications of the Fukushima Daiichi accident on the safety of HTGRs. A new coordinated research programme will assess the safety of HTGRs as well as defining severe accident scenarios. This activity will contribute to the on-going effort of making the IAEA Safety Guides and Standards technology-neutral. The next TWG-GCR meeting will be held in March 2015 in Vienna.

Contact: Bismark Tyobeka, NPTDS;
B.M.Tyobeka@iaea.org

ICSP Validates Computer Codes for Integral PWR

The integral Pressurized Water Reactor (PWR) concept is one of the innovative reactor types with a high probability of near term deployment. It contains nuclear steam supply systems within the reactor vessel.

An IAEA International Collaborative Standard Problem (ICSP) on **Integral PWR Design Natural Circulation Flow Stability and Thermo-hydraulic Coupling of Primary System and Containment during Accidents** has been conducted since 2010. Oregon State University, USA, offered its experimental facility, built to demonstrate the feasibility of the Multi-Application Small Light Water Reactor (MASLWR) design. Seventeen institutes from seven IAEA Member States participated in this ICSP.

“The ICSP has assessed computer codes for reactor system design and safety analysis”, said Jong Ho Choi from the IAEA Nuclear Power Technology Development Section. “To achieve this, the ICSP participants produced experimental data and conducted computer code simulations of the experiments”.

The purpose of this ICSP was to improve the understanding of natural circulation phenomena expected to occur in integral type PWRs; evaluate system code capabilities to predict natural circulation phenomena for integral type PWR, their practicality and efficiency, by simulating an integrated experiment; supply experimental data for single/two-phase flow natural

circulation instability and long-term cooling by natural circulation through coupled primary system and containment; and suggest code improvements or new experiments to reduce uncertainties.

In the MASLWR test facility, two different experiments were conducted: the first one was normal operating conditions at different power levels, and the second simulated a loss of feed-water transient with subsequent automatic depressurization system blowdown and long term cooling by primary-containment coupling.

The ICSP was conducted in three phases: **pre-test simulation** with designed initial and boundary conditions before conducting the experiment, **blind simulation**, with real initial and boundary conditions after the experiment, but without seeing the experimental data and **open simulation**, after observation of the real experimental data.

The final results of the ICSP were shared at a meeting in Pisa, Italy, in February 2013. The IAEA ICSP provided all participants with the opportunity to evaluate the strength and weakness of their system codes in the transient analysis for an integral reactor.

ICSP Results: the helical coil steam generator is used for many integral type reactors. The ICSP found that the helical coil heat exchanger improves the heat transfer significantly compared to the conventional U-tube bundle steam generator.

Helical Coil Steam Generator in MASLWR

Natural circulation is an effective cooling mechanism for accidents in the MASLWR concept. For the entire transient of loss of feed-water event, there was no core uncovery, and core cooling was maintained by different modes of natural circulation.

Most existing advanced codes do not have appropriate heat transfer models for the helical coil steam generator. Further study of the heat transfer in the helical coil heat exchanger is recommended, including incorporation of the findings into the system codes.

Contact: Jong Ho Choi, NPTDS; J.H.Choi@iaea.org

Nuclear Power Engineering

IAEA Technical Working Group on Life Management of Nuclear Power Plants

The IAEA held the biennial meeting of the Technical Working Group on Life Management of Nuclear Power Plants (TWG-LMNPP) in Vienna on 20−22 February 2013.

The focus of interest of the TWG-LMNPP is plant life management and long term operation beyond design life time. Ageing management covers all aspects of ageing assessment and mitigation including design, engineering, operations and maintenance actions to ensure safe continued operation and to control, within acceptance limits, ageing degradation and wear of key components of the plants.

The meeting provided a forum for information exchange on nuclear power plant life management for long term operation, provide technical support to the 2014−2015 programmes in this area, and propose future activities for 2016−2017.

Meeting of the TWG-LMNPP at the IAEA, February 2013.

"The most important lesson that we have learned from the Fukushima Daiichi accident is that we need a more intense focus on nuclear safety", said IAEA Deputy Director General for Nuclear Energy Alexander Bychkov. "The IAEA Action Plan on Nuclear Safety, which was approved by all Member States, is now being implemented as a programme of work to strengthen the global nuclear safety framework".

He encouraged TWG members to share their experience and expertise with expanding and new nuclear power programmes and proposed that TWG members focus on this issue when providing recommendation for 2016–2017.

The TWG members also discussed preliminary plans for the 4th International Conference on Nuclear Power Plant Life Management for Long Term Operation, to be held in 2017 and identified Europe as the preferred location for this conference. The 3rd conference on this topic was held successfully in May 2012 in Salt Lake City, USA (see Nuclear Power Newsletter, September 2012).

"The IAEA is working to reflect and consolidate Member States' needs into all IAEA programme activities. We are collecting information, opinions, and suggestions from Member States through mechanisms such as meetings, coordinated research projects, and international forums", said Ki Sig Kang, Scientific Secretary of the TWG-LMNPP and Technical Head for Plant Life Management/Long Term Operation in the IAEA Nuclear Power Engineering Section.

"The Technical Working Group actively promotes collaboration from Member States in coordinated research programmes and supports the implementation of results", Mr Kang added.

Contact: Ki Sig Kang, NPES; K-S.Kang@iaea.org

Design Review Process for Nuclear Power Plants

Maintaining the safe operation of a nuclear power plant requires that its initial design – and any changes made during the plant's lifetime – are constantly reviewed by a meticulous and structured process. These reviews should be done with a full understanding of all the design information, and specifications for each system and component, including the associated margins in safety and efficiency for that plant.

To that end, the IAEA organized a technical meeting on the **Design Review Process to Support Expanding and New Nuclear Power Programmes** in Vienna, 13–15 March 2013. Thirty-two experts from 17 Member States and two international organizations discussed issues including experiences, knowledge and enhancement of the design process, the ongoing search for better and more efficient design management, processes, and design authority roles and responsibilities.

"Cooperation and information exchange among the owner/operators, industry members, regulatory bodies, and technical organizations is essential to improve safety of nuclear power", said Jong Kyun Park, Director of the IAEA Division of Nuclear Power. "We must continuously strive to identify better, more efficient and more reliable processes".

When a plant is built, its design is the result of an integrated process that involves many entities including the reactor supplier and architect–engineer, designers and suppliers of components and many others involved in the construction and commissioning of a nuclear power plant. The owner/operating organization is usually a customer of those entities but bears the full responsibility for the design of the facility and for its verification. Thus the operating organization must be able to understand, and be a knowledgeable customer about, the design of a nuclear power plant from the early design stage through the implementation and also keep records on all design information.

"Newcomer countries will need a mature design support team", said Mr Park. "The selected technology must be reviewed to ensure that the design meets the legal, environmental, safety, contractual and technical requirements and that any necessary design changes and site specific adaptations are identified and defined".

The meeting discussed the roles of owner/operating organizations in the design review process including a turn-key project; the interfaces of owner/operating organizations with technical support organizations during the design stages; and the challenges and solutions for owner/operating organizations and technical service. Participants agreed that this technical meeting provided an excellent opportunity to share, learn and adopt efficient and effective practices, methods and a proven process for the safe and efficient design, construction and operation of a nuclear power plant.

Contact: A. Nesimi Kilic, NPES; A.Kilic@iaea.org

I&C for Atucha-Type Nuclear Power Plants

Argentina's national nuclear energy agency (CNEA) hosted a Technical Cooperation (TC) Workshop on **Instrumentation and Control (I&C) Obsolescence Issues and Digital I&C Modernization Approaches** in March 2013 in Buenos Aires. Fifty participants from three national nuclear organizations attended lectures by experts from Argentina, Canada, Germany, the Republic of Korea, the UK and the IAEA.

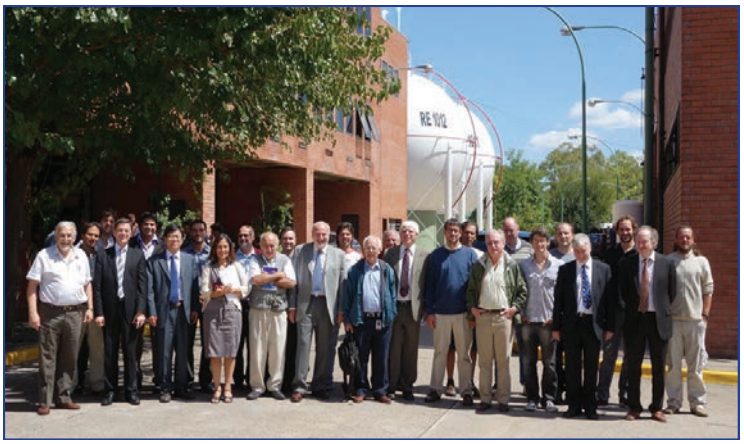
Design, licensing, testing, operation, maintenance of modernized I&C systems and coping with obsolescence problems were addressed. "We paid particular attention to the design and licensing of advanced I&C systems, including Field Programmable Gate Array (FPGA) based systems, and to on-line monitoring systems and applications in operating nuclear power plants", said Janos Eiler, from the IAEA Nuclear Power Engineering Section and Scientific Secretary of the workshop. Presentations and discussions covered:

- Safety objectives and I&C design
- I&C modernization strategies
- New challenges in the design of digital safety installations
- Execution process of I&C modernization projects
- FPGA applications in I&C modernization projects
- Verification and validation of I&C systems for nuclear applications
- Obsolescence aspects and a brief overview of the Atucha nuclear power plant
- Localization of digital I&C for nuclear power plants
- Overview of on-line monitoring (OLM) approaches
- Use of OLM for condition based maintenance of safety critical sensors
- Integrated OLM and the way forward.

Atucha Nuclear Power Plant

A visit to the Atucha nuclear power plant was another highlight of the programme. Participants learned about the ongoing commissioning activities of the modernized Atucha I&C systems and the general status of the Atucha II plant construction. A tour of the site included access to the reactor area inside containment. Because of the success of the workshop, the host organization expressed interest in continuing this programme.

Contact: Janos Eiler, NPES; J.Eiler@iaea.org



Participants in the TC Workshop, held at CNEA in Buenos Aires.

I&C Application of Field Programmable Gate Arrays—FPGAs

Nuclear power plants operating worldwide are or will be facing the need to replace or upgrade both analogue and digital I&C systems, while new plants are being designed with new I&C systems. In both cases there is a need for such advanced systems, and safety and safety-related systems need to be qualified and accepted. Historically, the majority of these systems have been based on microprocessor technology. However, getting regulatory approval for microprocessor-based systems can be costly and time-consuming causing implementation delays. In addition, small simple systems, whether safety, safety-related or non-safety, can be quite costly when developed using microprocessor technology.

Field-programmable gate arrays (FPGAs) are gaining increased attention worldwide for application in nuclear power plant I&C systems, particularly for safety and safety-related applications, but also for non-safety ones. Nuclear power plant operators and equipment suppliers see potential advantages of FPGA-based digital I&C system applications, as compared to microprocessor-based applications. 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 have now started to appear 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, the IAEA joined in the sponsorship of a Topical Group on FPGA Applications in Nuclear Power Plants (TG-FAN). The TG-FAN has now met annually for the past five years and identified a need for a document on the application of FPGAs in I&C systems in nuclear power plants to assist plant owners, suppliers, regulators and researchers. Hence, the IAEA has agreed to prepare this document. At a meeting held in February 2013 at the IAEA, a team of eight experts from five Member States formulated the extended outline of the new IAEA Nuclear Energy Series publication, covering the various aspects of the application of FPGAs in nuclear power plants.

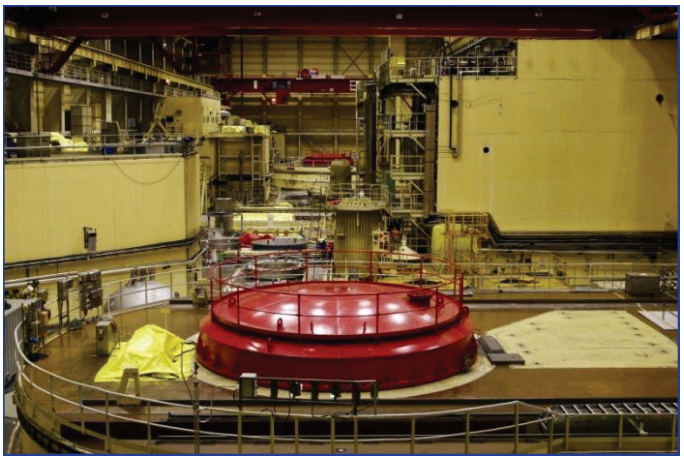
As a next step, the draft document will be reviewed by the participants of the next TG-FAN meeting, to be held in the second half of 2013. It will be finalized in a subsequent Consultants Meeting in early 2014 and published next year.

Contact: Janos Eiler, NPES; J.Eiler@iaea.org

Water Chemistry Guidelines for WWER Plants

Chemistry control is one of the most important disciplines and activities in the operation of nuclear power plants. A number of countries are operating WWERs (water-water power reactors) and they all have different national capabilities and, in several cases, different circuit chemistry guidelines, criteria and philosophy underlying the control and management of water chemistry.

The IAEA organized a meeting on 18−20 March 2013 to harmonize WWER water chemistry regimes, disseminate best practices and incorporate experiences in advanced pressurized water reactor (PWR) water chemistry performance. A harmonized approach to WWER water chemistry would be helpful and PWR water chemistry experiences could then be used to improve WWER water chemistry performance. An IAEA document will describe specific guidance and the technical bases for the control of chemistry parameters, impurity effects and the application of action levels and zones for WWER nuclear power plants. It covers both primary and secondary systems, as well as auxiliary systems. Publication of the document is expected in the 4th quarter of 2013.



Hungary is operating WWERs at the Paks Nuclear Power Plant.

Contact: Keeyoung Kim, NPES; Keeyoung.Kim@iaea.org

Twenty Years of Country Nuclear Power Profiles

Twenty years after the project on Country Nuclear Power Profiles (CNPP) was initiated in 1993, the IAEA organized a Technical Meeting on 18–21 March 2013 to mark the 20th anniversary of the project and discuss latest developments and future plans for CNPP.

CNPP are a comprehensive and unique compilation of data and statistics on the status and development of nuclear power programmes in Member States. The profiles consolidate information about nuclear power infrastructure in the participating countries, and present factors related to the effective planning, decision making, and implementation of nuclear power programmes and their safe and economic operations.

The CNPP's descriptive and statistical overview of the economic, energy and electricity situation in each country, and its nuclear power and related legislation framework are intended to serve as an integrated source of information about nuclear power programmes in the world. It is an excellent platform for exchange of information and experience, and requires a periodical review and update to reflect global developments in nuclear power and in the electricity market.

The CNPP project was set up in response to Member States' needs for a database and technical document that summarizes the economic situation, the energy and electricity sector and the primary organizations involved in nuclear power in IAEA Member States.

In the following years, the scope and objectives of the CNPP were discussed at expert meetings, the document structure was designed and a network of CNPP collaborators was established.

"Today, 51 countries are contributing their data and statistical information to the CNPP, and the number of participating countries has increase with every new edition", said Jiri Mandula from the IAEA's Nuclear Power Engineering Section, who is managing the project. "This includes 29 countries with operating nuclear power plants, and 22 countries with past or planned nuclear power projects".

The first CNPP edition published in 1998 contained reports from 29 countries only. Since then, the IAEA has published eleven editions of the CNPP, the latest in 2012. Since 2008, the CNPP is available on CD-ROM and on the IAEA's website.

In support of IAEA activities on nuclear power infrastructure development for newcomer countries, Member States who are planning to include nuclear power in their country's energy mix have been invited to join the CNPP, for example Belarus, Bangladesh, Egypt, Indonesia, Turkey, the United Arab Emirates and Vietnam.

In 2009, the structure of the CNPP was extended to include more detailed information on nuclear power infrastructure development and future projects. The 2012 edition features a new interface with a unique graphical tool for CNPP report selection.

Each country report can be displayed either with the complete text or in statistical tables only.

The CNPP 2012 edition is available at:

http://www-pub.iaea.org/MTCD/Publications/PDF/CNPP2012_CD/pages/index.htm

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

Development of a Construction e-Learning Module

Sixty-eight nuclear power reactors are currently under construction. Expansion as well as near and long term growth prospects remain centred in Asia, particularly in China. Of the total number of reactors under construction, no fewer than 43 are in Asia, as are 38 of the last 48 new reactors that have been connected to the grid.

To support construction management, a number of nuclear construction experts and senior managers met at the IAEA, 4–7 February, to develop an e-learning module on construction management, with a particular focus on countries starting or expanding nuclear programmes and their specific needs.

Nuclear construction experts and senior managers discussed such issues as what makes nuclear construction unique, what considerations are important at a national or regional level, planning and organization of nuclear construction projects, advanced construction technology, and methods to achieve excellence.

This module will be one of a series of interactive e-learning modules that the IAEA is preparing to help newcomer countries as well as countries expanding their nuclear power programmes (see p. 13).

All modules are based on the IAEA Nuclear Energy Series publication *Milestones in the Development of a National Infrastructure for Nuclear Power* (NG-G-3.1), other IAEA publications and feedback from Member States.

Contact: John Henry Moore, NPES; J.H.Moore@iaea.org

Construction of the Sanmen AP1000, China. Photo: Chen Yin, Sanmen, CNNC

Supporting Nuclear Infrastructure Development

Integrated Nuclear Infrastructure Group (INIG)

IAEA Annual Technical Meeting on Nuclear Power Infrastructure

About 85 nuclear policymakers and senior managers met at the IAEA, on 11−14 February 2013, to discuss nuclear power infrastructure development, with a particular focus on countries starting nuclear power programmes and their specific needs. They represented 42 Member States from Africa, Asia, Europe and Latin America and were from countries that are introducing, expanding or commercializing nuclear power plants. The EC and the World Association of Nuclear Operators (WANO) were also represented. In addition, 25 experts from across the IAEA attended.

It was the **7th Technical Meeting on Topical Issues of Infrastructure Development** held since this meeting series was established in 2006. Previous meetings had covered knowledgeable decision-making and awareness building, infrastructure development and the implications of the Fukushima Daiichi nuclear accident.

The 2013 technical meeting focused on **Nuclear Power Project Development in Emerging Nuclear Power States** and served as a forum for sharing experience, especially regarding the management of both new and expanding nuclear power projects. The meeting was chaired by William Raisin, USA, and Franklin E. Osaisai from Nigeria. In seven sessions, the participants discussed issues mainly related to:

- Building knowledgeable and responsible owner-operator organizations to manage a nuclear power plant project;
- Establishing operational and independent regulatory bodies, which are able to define the rules for safety, security and safeguards, including the licensing process and other key functions.

"The Agency has been focused on helping new owner-operators become knowledgeable customers. This is important because these organizations will have the primary responsibility for safety", said Alexander Bychkov, IAEA Deputy Director General for Nuclear Energy.

Opening Session of the Technical Meeting with IAEA Deputy Director General A. Bychkov, Chairs F.E. Osaisai, Nigeria, and W. Raisin, USA (right), and INIG Group Head Anne Starz (left).

The meeting offered an excellent opportunity for networking.

"Many of the sessions addressed the needs of countries introducing nuclear power as they move into Phase 2 of the IAEA's Milestones approach, which ends with inviting bids for the first nuclear power plant", said Vincent Nkong-Njock from INIG, who served as Scientific Secretary of the meeting. Participants also discussed siting, feasibility studies, licensing, contracting, construction and stakeholder involvement. In addition, experiences using IAEA review services such as the Integrated Nuclear Infrastructure Review (INIR), Integrated Regulatory Review Service (IRRS), Emergency Preparedness Review (EPREV), International Physical Protection Advisory Service (IPPAS), and International State System of Accounting for and Control of Nuclear Material Advisory Service (ISSAS) were shared.

The Technical Meeting also included breakout sessions focusing on operational owner-operators and independent regulatory bodies, covering (1) financial risks, (2) vendors' expectations from States, (3) TSO and R&D infrastructures in support of nuclear power plants, (4) capacity building of regulatory bodies, (5) cooperation with vendor regulatory bodies, and (6) licensing systems.

Interesting themes emerged about the partnership that forms between the vendor and the new owner. An effective cooperation between the regulatory bodies was also found to be equally important. It was therefore agreed upon that developing the capability to be a knowledgeable customer, and an operational and independent regulatory body involves understanding the technical issues, forming an appropriate project team within the owner organization, understanding the nature and complexity of the project, and establishing a proper 'nuclear' culture, mechanisms and management systems.

"Much progress has been achieved since 2006, and we have learned many lessons", said Anne Starz, Head of the IAEA Integrated Nuclear Infrastructure Group. "One of them is that countries need *tailored* assistance from the IAEA, depending on the status of the national nuclear power programme. Also, it is important to prioritize and coordinate activities within the country and with the IAEA."

All presentations are at **http://www.iaea.org/NuclearPower/Meetings/2013/2013-02-11-02-14-TM-INIG.html**

Contact: Vincent Nkong-Njock, INIG; V. Nkong-Njock@iaea.org

INIR mission to South Africa, the first country with an operating power reactor taking advantage of this IAEA service.

Recent INIR Missions

Over the past several months, IAEA-led teams of international experts carried out three Integrated Nuclear Infrastructure Review (INIR) missions to assist Member States in developing their nuclear power programmes.

South Africa – an INIR for Expansion

As the first country with operating nuclear power plants, and the first in Africa, South Africa hosted an INIR mission on 30 January−8 February 2013. A team of international and IAEA experts, assembled at South Africa's request, observed strong government support for the country's nuclear expansion programme, noted strengths, and made recommendations for further actions.

“The mission has made a thorough review of all areas of South Africa's nuclear infrastructure," said IAEA Director General Yukiya Amano during his visit to South Africa which coincided with the INIR mission. "I warmly congratulate South Africa on this significant move to ensure a robust framework for expansion of its nuclear power programme."

"This mission could not have come at a more important time for our country," said Nelisiwe Magubane, Director General of South Africa's Department of Energy. "The INIR mission has strengthened the expertise and also the cooperation amongst the nuclear industry in South Africa. It has also given us an opportunity to extend public engagement in preparation for the expansion of the nuclear programme."

South Africa currently has Africa's only commercial nuclear power plant, at Koeberg in the Western Cape. The Koeberg Nuclear Power Station started operation in 1984, and its two reactors generate five percent of the country's electricity. The South African government is committed to expanding its nuclear power programme, and asked the IAEA to conduct an INIR mission to review its infrastructure and identify areas for improvement.

The INIR team identified strengths in several areas supporting both the existing and new build programme, including regulatory self-assessment, environmental impact assessment, grid development and stakeholder involvement. It also made recommendations and suggestions to help South Africa strengthen its nuclear infrastructure as it expands its nuclear power programme.

The INIR mission was conducted in a cooperative and open atmosphere, with participation from the main organizations in South Africa responsible for the nuclear power programme; in particular, the Department of Energy, Department of Mineral Resources, National Treasury, Department of Science and Technology, Department of Environmental Affairs, Department of Public Enterprises, Department of Trade and Industry, Eskom, National Nuclear Regulator, South African Nuclear Energy Corporation.

Contact: Pal Vincze, NPES; P.Vincze@iaea.org

Poland – Progressing with its Nuclear Power Programme

Poland invited an INIR mission to review progress made in introducing nuclear power in the country’s energy mix.

An international team of experts, assembled at Poland's request by the IAEA, conducted an INIR mission in Poland on 18−22 March 2013. They found that significant progress has been made in the development of the country's nuclear infrastructure. The mission team also noted good practices and made recommendations for further actions.

"This mission is a great motivation for increased efforts and greater activity in preparation for our nuclear power programme," said Hannah Trojanowska, the Polish Government's Commissioner for Nuclear Energy and Undersecretary of State, Ministry of Economics. "The situation is dynamic and Poland will continue to use IAEA expertise and knowledge to enhance these activities".

Hanna Trojanowska, Commissioner for Nuclear Energy (centre), Zbigniew Kubacki, Director of the Nuclear Energy Department, Ministry of Economy of Poland (right) and IAEA mission team leader Juan Carlos Lentijo.

All participants in Poland's nuclear power programme were involved in the discussions with the INIR mission team including government organizations, regulatory authorities and the future operating organization, Polska Grupa Energetyczna SA (PGE).

In 2009, the Polish Government made the decision to launch a nuclear power programme to diversify its sources of power generation, ensure the country's long-term electricity supply, meet commitments resulting from the EU Climate and Energy Package and reduce CO_2 emissions.

Today, Poland is highly dependent on coal which provides about 90% of the country's energy. Three potential sites are under consideration for the planned nuclear power plant: Choczewo, Gaski and Zarnowiec. PGE plans to install around 3000 MWe of nuclear capacity, with its first unit expected to be online by 2025.

The INIR mission team reviewed the 19 issues of the Milestones approach in an open and constructive way. "Poland has completed most of the actions proposed for Phase 1 of developing a nuclear power programme", said Juan Carlos Lentijo, Director of the IAEA Division for Nuclear Fuel Cycle and Waste Technology and leader of this INIR mission team. "Poland is now progressing with a number of Phase 2 activities. In particular, the future owner/operator, PGE, is already identified and is developing key strategies for procuring the first nuclear power plant. Also, the Ministry of Economy and PGE have undertaken a comprehensive awareness and stakeholder involvement process, including transboundary consultation".

Contacts: Fanny Bazile and Yuri Troshchenko, INIG; F.Bazile@iaea.org, Y.Troshchenko@iaea.org

Vietnam – Second INIR Mission

Prior to these missions, at the end of 2012, the IAEA conducted the second INIR mission in Vietnam. The international expert team, led by Jong Kyun Park, Director of the IAEA Nuclear Power Division, reviewed Vietnam's programme for introducing nuclear power, and found that it enjoyed strong governmental support. The experts also recognized the significant progress achieved, including active preparation for the construction of the Ninh Thuan Nuclear Power Project.

"The IAEA INIR Mission's recommendations and suggestions are valuable to Vietnam as a newcomer to nuclear power. We will study and report these recommendations and suggestions to the Government, as well as to the National Assembly," said Nghiem Vu Khai, Vice-Minister of Vietnam's Ministry of Science and Technology.

The government of Vietnam approved its first nuclear power project in the Ninh Thuan region in 2009. Vietnam concluded an Intergovernmental Agreement (IGA) with Russia in 2010 and with Japan in 2011, for the construction of nuclear power plants at different sites in Ninh Thuan province.

For the INIR mission to Vietnam, an updated Evaluation Methodology document was used on a trial basis, which incorporated lessons learned from the previous INIR missions and the accident at the Fukushima Daiichi nuclear power plant, as well as recently developed IAEA documents.

Contact: Masahiro Aoki, INIG; M.Aoki@iaea.org

About the INIR Mission

The INIR mission is an integral part of the IAEA's Milestones approach, documented in the IAEA publication *Milestones in the Development of a National Nuclear Infrastructure for Nuclear Power* (IAEA Nuclear Energy Series No. NG-G-3.1).

There are three phases of development of a national nuclear infrastructure programme which cover 19 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 completion of each phase is marked by a specific 'milestone' at which progress can be assessed. Milestone 1 is when a country is ready to make a knowledgeable commitment to a nuclear programme, Milestone 2 is when it is ready to invite bids, and Milestone 3 is when it is ready to commission and operate its first nuclear power plant.

Contact: Anne Starz, INIG; A.Starz@iaea.org

The INIR Mission team and Vietnamese representatives at the INIR Workshop in Hanoi.

E-learning for Nuclear Newcomers

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

The IAEA has launched a new e-learning series to help newcomer countries as well as those expanding their nuclear power programmes. The interactive modules will cover the 19 infrastructure issues of the IAEA Milestones approach, and bring decades of expertise to life.

- **Module 1: Implementing a Nuclear Power Programme**, is an introduction and overview of nuclear power infrastructure development.
- **Module 2: Developing a Human Resource Strategy**, focuses on human resources management, a crucial element of a nuclear power programme.

Soon other modules will be available:

- **Stakeholder involvement**
- **Management of a new nuclear power programme**
- **Construction management**.

This e-learning project is supported by an extrabudgetary contribution from the Republic of Korea under the Peaceful Uses Initiative. It is implemented by the Integrated Nuclear Power Infrastructure Group (INIG) with support from the Nuclear Power Engineering Section (NPES) of the Division of Nuclear Power, Department of Nuclear Energy.

All modules are based on the IAEA Milestones approach (Nuclear Energy Series No. NG-G-3.1), other relevant IAEA publications and current experiences from newcomer countries. The modules are available at the above web page.

Contact: Anne Starz, INIG; Anne.Starz@iaea.org

Role of Research Reactors in the Development of Nuclear Power Programmes

At a recent technical meeting held at the IAEA, experts from newcomer and operating countries discussed the role of research reactors and related infrastructure in the development of a nuclear energy programme. Historically, nuclear power programmes evolved from national programmes to develop nuclear science and technology capabilities. Different approaches are emerging nowadays in countries embarking on programmes to develop nuclear power.

Jordan is following an historical approach and constructing both a 5 MWth research reactor as well as a subcritical facility before the subsequent development of nuclear power.

The **United Arab Emirates** is opting to import foreign expertise and access research reactor capabilities via international networks, in parallel with programmes to develop national nuclear expertise.

Several Member States with at least one research reactor are choosing to access research reactors in other Member States through international networking programmes.

Belarus, Thailand and **Vietnam** are considering building new research reactors, but technically, these new facilities focus mainly on non-power applications, with some support provided to their nuclear power programme.

The meeting participants agreed that it appears possible to develop a nuclear power programme without a domestic research reactor. They also agreed that any new research reactor should be justified, and a comprehensive utilisation plan should be developed during the earliest phase of the project.

The sustainability of research reactors will not only be ensured by supporting the nuclear power plant in the long term, but also government financing will be required for decades.

The majority of newcomers with existing research reactors mentioned that this type of reactor helped them to be more confident about nuclear technology and that research reactors have been used for basic education in the nuclear power field in cooperation with universities or other technical education institutions. Experienced staff have often served in an advisory role or, in some cases, have become part of the nuclear workforce.

The potential contribution of a domestic research reactor depends heavily on its power level, specific capabilities, whether the facility has demonstrated good operational and safety performance, whether the organisation maintaining the research reactor has earned the trust of national and potential international stakeholders, and the age of the reactor and experience of the staff.

Contacts: Marta Ferrari, INIG; M.Ferrari@iaea.org
Ed Bradley, NEFW; E.Bradley@iaea.org
Brian Molloy, NPES; B. Molloy@iaea.org

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

7th GIF-INPRO Interface Meeting

Some 40 experts of the Generation IV International Forum (GIF) and the IAEA/INPRO met on 28 February−1 March 2013 to share information on progress and future activities related to R&D and technology innovation of nuclear energy systems. This was the 7th Interface Meeting between the two organizations since 2003. It was organized jointly by INPRO and the IAEA's Nuclear Power Technology Development Section (NPTDS).

"Our cooperation is important for the future of nuclear power, particularly for innovative reactors, small and medium-sized reactors and more sustainable systems, which are all areas covered in the IAEA's technical programme", said Alexander Bychkov, IAEA Deputy Director General for Nuclear Energy. "Assessment, analysis and dissemination of information among Member States regarding evolutionary and advanced reactor technologies, and closed sustainable fuel cycles including transition from thermal to fast reactors remain a high priority for the Department of Nuclear Energy".

GIF coordinates research activities on six next generation nuclear energy 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.

Representatives of GIF and the IAEA met for the 7th GIF/INPRO Interface Meeting in Vienna.

"GIF is currently conducting a strategic planning exercise and one of the recommendations of this exercise is that we need to strengthen our relationships with other organizations such as the IAEA", said John Kelly, the new Chair of GIF. "Our relationship with INPRO and IAEA Technical Working Groups is among the most important of our outreach activities and we need to continue to build on this success".

Nuclear Safety

This was a major discussion item: IAEA experts from the Department of Nuclear Safety and Security provided a briefing on the implementation of the IAEA Action Plan for Nuclear Safety, on the IAEA Design and Safety Assessment Review Service (DSARS) and generic reactor safety reviews. Many other activities, such as the European Project on Safety Assessment for Reactors of Generation IV (SARGEN IV), the GIF evaluation methodology in the area of safety and the GIF/IAEA Workshop on SFR Safety Design Criteria, held just prior to this meeting (see p. 4), are focused on the development of the safety basis of this next generation nuclear system.

Proliferation Resistance

GIF and the IAEA/INPRO have been cooperating on assessment methodologies in the areas of proliferation resistance and economics for several years. The meeting heard presentations on, and discussed the update of, the INPRO Methodology in the area of proliferation resistance and the INPRO Collaborative Project on Proliferation Resistance and Safeguardability Assessment Tools (PROSA). GIF presented its evaluation methodology on proliferation resistance and physical protection, which is a systematic approach to evaluating vulnerabilities in design concepts. Both methodologies are complementary and useful in national programmes.

Economics

In terms of economic assessment methodologies, the IAEA presented its energy system modeling tools that are provided through the IAEA Planning and Economic Studies Section as part of capacity building support for Member States. There are seven analytical tools, including e.g. the Model for the Analysis of Energy Demand (MAED) and the Model for Energy Supply System Alternatives and their General Environmental Impacts (MESSAGE).

Energy system planning and modeling is a necessary prerequisite to a Nuclear Energy System Assessment (NESA) using the INPRO Methodology. One of the tools available to Member States is NEST, the NESA Economic Support Tool, which is a VBA/MS Excel tool developed in 2010 and applied in several NESA studies and collaborative projects so far. It comprises several models and options and calculates parameters necessary for the INPRO economic assessment, while GIF has developed and is monitoring the application of G4ECONS, the GIF Cost Estimating Methodology.

"We also presented latest developments in the INPRO Collaborative Projects SYNERGIES and ROADMAPS and provided an overview of the planned revision of the INPRO Methodology", said Jon Phillips from the INPRO Group, who served as one of the Scientific Secretaries of the meeting, jointly with Stefano Monti from NPTDS.

This was a very productive meeting with substantial and substantive discussions. The collaboration between the two organizations has deepened so that the various working groups and task forces are actually helping each other learn how the INPRO and the GIF methodologies are similar and how they are different, which increases the learning of both organizations.

Contacts: Jon Phillips, INPRO; J.R.Phillips@iaea.org, Stefano Monti, NPTDS; S.Monti@iaea.org

Romania to Undertake a NESA

Romania has requested support from the IAEA to complete a NESA using the INPRO Methodology. In August 2012, Romania became a Member of INPRO and announced its intention to perform an assessment of their nuclear energy system with a particular focus on the selection of potential deployment options. The Nuclear Energy and Radioactive Waste Agency of Romania (ANDR) has taken responsibility for carrying out the assessment in the areas of economics, infrastructure, waste management, proliferation resistance, physical protection, safety and the environment.

"The NESA may help Romania to compare different nuclear energy systems to find the best scenarios for the sustainable development of our country", said Mr. F.C. Tatar, President of ANDR. "The assessment results will be provided to the IAEA as a contribution from Romania for its membership in INPRO".

Romania's only nuclear power plant is located in Cernavoda. Two CANDU-6 units have been in operation since 1996 and 2007, producing roughly 20% of the country's electricity.

ANDR hosted the NESA meeting in Bucharest on 12−13 March 2013 2013.

Cernavoda Nuclear Power Plant, Romania. Photo: http://en.wikipedia.org

Two further units at Cernavoda are partially completed, and plans to finish construction of these units are in preparation. In addition to the reactors, Romania has supporting facilities including uranium mining, milling and conversion, CANDU fuel bundle fabrication and a heavy water plant. These facilities are scaled to fully supply the existing operations at the Cernavoda nuclear power plant.

In mid-March 2013, two experts from the INPRO Group were invited to participate in a preparatory meeting, hosted by ANDR in Bucharest. The meeting was attended by 15 national experts from ANDR, the Ministry of Economics, the national regulatory body and nuclear utility and research institutions to prepare and discuss the planned assessment.

"We discussed the scope and organization of the project, as well as future collaboration between ANDR and the IAEA and the interaction among the national nuclear institutions to be involved in the NESA", said Jon Phillips of the INPRO Group.

The INPRO experts provided an introduction to the INPRO Methodology, presented basic principles of the assessment, gave a brief overview of the experience from other NESA studies, and led a discussion between the IAEA experts and the national team on how to adapt the NESA to the particular needs of Romania. They also introduced the main features of a NESA, presented a NESA support package developed by the IAEA to assist Member States in carrying out the assessment, and prepared draft terms of reference for the planned project.

The Romanian NESA study will be divided into two stages. In Stage 1, which would last about two years, future nuclear energy system scenarios, including the existing system, will be modeled and the areas of economics, infrastructure and waste management will be assessed using the INPRO Methodology. During Stage 2, which is scheduled thereafter, the areas of proliferation resistance, physical protection, environment and safety of reactors and fuel cycle will be assessed. The Romanian nuclear authority intends to use the results of the NESA to support specific plans for developing the country's nuclear energy sector.

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

Preparing for INPRO's ROADMAPS Project

While there are several on-going national and international efforts on technology development for innovative nuclear reactors and fuel cycles, roadmaps for a transition to globally sustainable nuclear energy systems (NES) still need to be elaborated.

Ten experts from seven Member States met with experts of the INPRO Group on 18–20 March 2013 at the IAEA to chart the way forward for a new INPRO Collaborative Project, entitled "Roadmaps for transition to globally sustainable nuclear energy systems" – or ROADMAPS for short. This collaborative project has the objective to develop a structured approach for achieving globally sustainable NES, providing models of cooperation among countries and a template for documenting actions, scope of work, and timeframes for specific collaborative efforts by particular stakeholders (the roadmap template).

All participants, who were from Indonesia, Malaysia, India, Romania, the Russian Federation, the USA and Vietnam, gave presentations on topics of relevance for the ROADMAPS project. In brainstorming and writing sessions, the project concept was reviewed and updated, the scope of issues to be addressed within the project was discussed, and proposals were developed for the ROADMAPS format and overall approach. Finally, the participants developed the draft terms of reference and made suggestions for the contents of the project report.

To make a meaningful contribution to the growing energy needs in the 21st century, nuclear energy needs to be made available at affordable levels for all countries. The ROADMAPS project will address several levels of NES sustainability starting from safe, secure, economical and publicly acceptable nuclear power with security of supply for newcomers, and ending up with advanced systems where all actinides are recycled. The roadmap template will, *inter alia*, indicate where savings in time, effort and resources needed to embark on a desired NES sustainability level could be achieved through collaboration among countries.

The roadmap template will address in detail the timelines, technologies, institutional mechanisms and the economic arrangements, and will summarize the drivers and impediments/options to overcome them, for a collaborative way to future sustainable NES. The template will provide a global view and guidance for regions or countries to develop their own, more specific roadmaps in a compatible format. As these regional or country-level roadmaps are developed and linked, the composite may grow into an integrated plan for achieving global sustainability of nuclear energy systems.

To achieve its objective, ROADMAPS will integrate the outputs of GAINS, SYNERGIES and several other INPRO collaborative projects, as well as the outputs of and the IAEA Technical Working Groups on nuclear reactors and fuel cycles. The collaborative project will, therefore, serve as an umbrella to facilitate effective use of the outputs of the INPRO projects by Member States. The ROADMAPS collaborative project will identify gaps on a collaborative way to globally sustainable NES but will leave it for future projects to develop solutions for those gaps.

The deliverable will be a periodically updated IAEA Nuclear Energy Series publication presenting the developed structured approach for achieving globally sustainable NES (the roadmap template and guidance). The report will include (as Annexes to the report, in the form of contributions from Member States) any collaborative or country level roadmaps that may be volunteered by participants during the term of the project.

The target audiences are decision makers and senior technical experts working in State institutions and non-governmental organizations, nuclear industry and utilities, and universities and R&D institutions working in the area of planning and implementation of a nuclear power programme.

The ROADMAPS project will be started in 2014 subject to the successful completion of the SYNERGIES collaborative project.

Participants in the Preparatory Meeting on the ROADMAPS project, IAEA, 18–20 March 2013.

Contact: Vladimir Kuznetsov, INPRO;
V.Kuznetsov@iaea.org

Nuclear Power Meetings 2013

A list of all meetings organized by the Division of Nuclear Power is available at

http://www.iaea.org/NuclearPower/Meetings/2013/index.html

Recently Published

Advances in High Temperature Gas Cooled Reactor Fuel Technology (CD-ROM), IAEA-TECDOC-CD-1674

PRIS-STATISTICS: Power Reactor Information System Statistical Reports —User's Manual
Computer Manual Series 22

Status of Fast Reactor Research and Technology Development, IAEA-TECDOC-1691 (also available on CD)

International Safeguards in Nuclear Facility Design and Construction, IAEA Nuclear Energy Series No. NP-T-2.8

This is the first of several new IAEA publications on Safeguards-by-Design that will provide guidance on the inclusion of safeguards considerations in nuclear facility design and construction. Prepared by the Department of Safeguards, it is published in the IAEA Nuclear Energy Series to reach a wider audience including nuclear power plant designers and customers.

The latest **IAEA Bulletin (54-1-March 2013)** has a specific focus on **Nuclear Power**. This issue supports the **International Ministerial Conference on Nuclear Power in the 21st Century,** St. Petersburg, Russian Federation, 27−29 June 2013 **(www.iaea.org/iaeameetings/).**

The objectives of the conference are to provide an opportunity to discuss, at the ministerial and international expert level, the role and viability of nuclear power in sustainable development, including climate change mitigation; its role in meeting the growing global requirements for electricity; and its status and prospects for the future.

Email: ministerial.conference2013@iaea.org

Inside the Division of Nuclear Power

New on the Team

Galina Fesenko, Nuclear Engineer INPRO Group

Galina Fesenko joined the INPRO Group as a cost-free expert from the Russian Federation.

She supports the activities of INPRO's Project on Global Nuclear Energy Scenarios. Previously, she worked at the National Research Nuclear University, Russian Federation, where she delivered lectures and undertook research work on analysis and modelling of nuclear energy systems. Galina has a PhD in Nuclear Physics from the Obninsk State Institute for Nuclear Power Engineering, Russian Federation.

Alexey Grigoriev, Senior Nuclear Engineer INPRO Group

Alexey Grigoriev joined the INPRO Group as a cost-free expert from the Russian Federation.

He is in charge of INPRO's Project on Innovations. Before coming to Vienna, he was Executive Director and Adviser of JSC TVEL – Fuel Company of SC "Rosatom" in the Russian Federation, where he was responsible for international projects on the nuclear fuel cycle. He holds an MSc degree in Physics from St. Peterburg State Electrotechnical University.

My Hometown

Perchtoldsdorf, Austria

By Elisabeth Dyck

If you like Austrian wine and a historic setting, then Perchtoldsdorf is the place to go. This small picturesque town is located right next to the southwestern border of Vienna and about 15 km from Vienna's city centre.

The town has a long history, dating back to the 12th century when a chain of fortresses was built on the eastern borders of the Vienna Woods. Among the historic sights is the *Herzogsburg* (Duke's Fortress) which served as a residence for widowed duchesses of the House of Habsburg in the 14th and 15th centuries. A 60-metre high peel tower has been the town's main landmark for half a millennium.

I've lived in the area for more than 20 years and still enjoy the charm of the small streets, historic houses that date back to the 15th and 16th centuries, little shops that offer customer-friendly personal service and the proximity to the Vienna Woods. The town is surrounded by fields, pastures and gently rolling vineyards.

Percholdsdorf 's tower was built between 1450 and 1521.

Annual wine growers festival.

Wine growing has a long tradition in this area and was first documented in 1248. *Grüner Veltliner, Neuburger and Weissburgunder* (Pinot blanc) are among the popular white wines cultivated here, while red wines include *Blauer Portugieser* and *Zweigelt*, to name a few. The many local wine growers serve their products in typical Austrian wine taverns, called *Heurigen*, along with simple homemade food. *Heurig* means 'this year' in German, which has given both the wine taverns and the new wine their name. Only in November of the following year does it become 'old' wine.

There are 41 Heurigen in Perchtoldsdorf, quite remarkable for such a small town. Their courtyards, often overgrown with vines and embellished with large potted oleander plants, offer a pleasant environment for a meal on a warm summer evening. During the colder seasons guests can enjoy the cozy indoors featuring wood-covered walls and tiled stoves.

The Perchtoldsdorf wine growers have a centuries-old tradition to express their gratitude for a rich harvest. On the first Sunday after St. Leonhard's Day (6 November) Perchtoldsdorf celebrates the procession of the *Weinhüter*, the guardians of the grapes before the harvest. This is probably Austria's most well-known wine growers' festival. There is a rich tradition of customs relating to wine, usually paired with music and dancing.

Elisabeth Dyck works as Communication Specialist in INPRO and in the Division of Nuclear Power.

Thodupuzha, India

by Roy George

Thodupuzha is the largest town in God's Own District (Idukki) of God's Own Country (Kerala state) in India. It is also the fastest growing town in Kerala and the district's main commercial centre. Thodupuzha is also the name of the river flowing through the centre of the town. Thodupuzha is blessed with natural scenic beauty.

The town's main landmark is the Civil Station, housing most of the governmental administrative offices. I graduated from Newman College, which is the main educational institution in the district. The name 'Thodupuzha' is considered to be derived from two words, 'thodu', which means a small stream and 'puzha', which means river. It is believed that the streams

Bridge across the Thodupuzha River.

nearby today's Thodupuzha developed into a river, and the town on the banks of the river came to be known as Thodupuzha.

The town's history dates back many centuries. The Buddhist and Jain religions, which made their first inroads into Kerala in 300 BC left their impact on Thodupuzha and its neighboring areas.

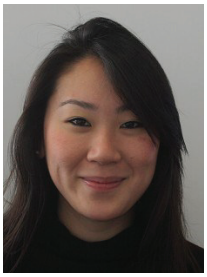
The economy is mainly driven by agriculture, business and small industries. Farmers raise a variety of crops, including pineapple, coconut, rice, coco, tapioca, rubber, and banana. Ginger, turmeric, pepper and other spices are also grown in plenty. In recent years, tourism has been promoted.

Civil Station, Thodupuzha.

Idukki is one of the most nature-rich districts, called the Spice Land of Kerala. There are many tea, cardamom, and pepper plantations. Asia's second largest arch dam for a hydroelectric project was constructed in the district. It is also a land of lakes and hills. The famous Thekkady Lake and the hilly tea plantation 'Munnar' are other sights.

Roy George is an Information Coordination Assistant in the Nuclear Power Engineering Section.

Tenerife, Spain



by Miriam Kim Park

Tenerife is one of the seven Canary Islands of Spain. I have a South Korean background, but I was lucky to be born and raised on this magic island that has made me feel a native. I have been able to keep the roots and traditions of my Korean family, while also enjoying the Spanish life style.

Tenerife is just 300 km off the African coast while the Spanish mainland is 1,300 km away. The warm Sahara currents

Spectacular lava rocks with Mount Teide in the background.

make it a special place, with a unique fauna and flora. Favourable weather conditions and an average temperature of 25 degrees C attract millions of tourists every year.

Tenerife is humid with a lush vegetation in the North, and sunnier and arid in the South. This combination makes it a unique place in the world. Its topography is very steep. You can swim in the sea while watching the snow-covered peak of Mount Teide. With an impressive height of 3,718 m, it is the highest point in Spain. Mount Teide is a 'sleeping' volcano in the centre of the Teide National Park. At about 2000 m altitude, a vast lava desert with unique colours and rock formations gives the impression of a 'moonscape'. The national park was declared a World Heritage site by UNESCO in 2007. It is Europe's most visited national park attracting millions of tourists and locals every year.

Los Gigantes, a resort on the west coast of Tenerife with giant rock formations.

This island is a perfect location for a vacation and to relax body and mind. It offers all kinds of water sport, fantastic golf courses, hiking, biking and discovering wild, untouched nature.

One of the island's main attractions is Tenerife's Carnival. Thousands of people gather in February every year for more than a week to celebrate and dance on the streets. It is said that this is the second most important carnival in the world after Rio de Janiero, and it was declared a Festival of International Tourist Interest in 1980.

The locals are kind and passionate people, always welcoming foreigners, and make tourists feel comfortable and happy to have chosen this place for their holidays. That's why the Canary Islands are called the 'fortunate islands'.

Miriam Kim is a Project Management Associate in the Integrated Nuclear Infrastructure Group.

View of Terracina from Mount Saint Angelo.

Terracina, Italy

by Antonio Toti

Since the times of the Roman Empire, Terracina has been known as a seaside resort. The small town is located between Rome and Naples, at the point where the *Roman Appian Way* reaches the Thyrrhenian Sea.

The city, older than Rome, was first an Etruscan, Volscian and then a Roman colony before becoming part of the Vatican State. It appears in ancient sources with two names, the Latin Tarracina and the Volscian Anxur.

The old town is located in the upper part of the city, and it is very charming with its little shops, typical small local taverns and a large variety of monuments and historical buildings. It is worth seeing the Forum Emiliano (now the Municipio square), where the S. Cesario Cathedral and many Roman ruins can testify to the history of the city.

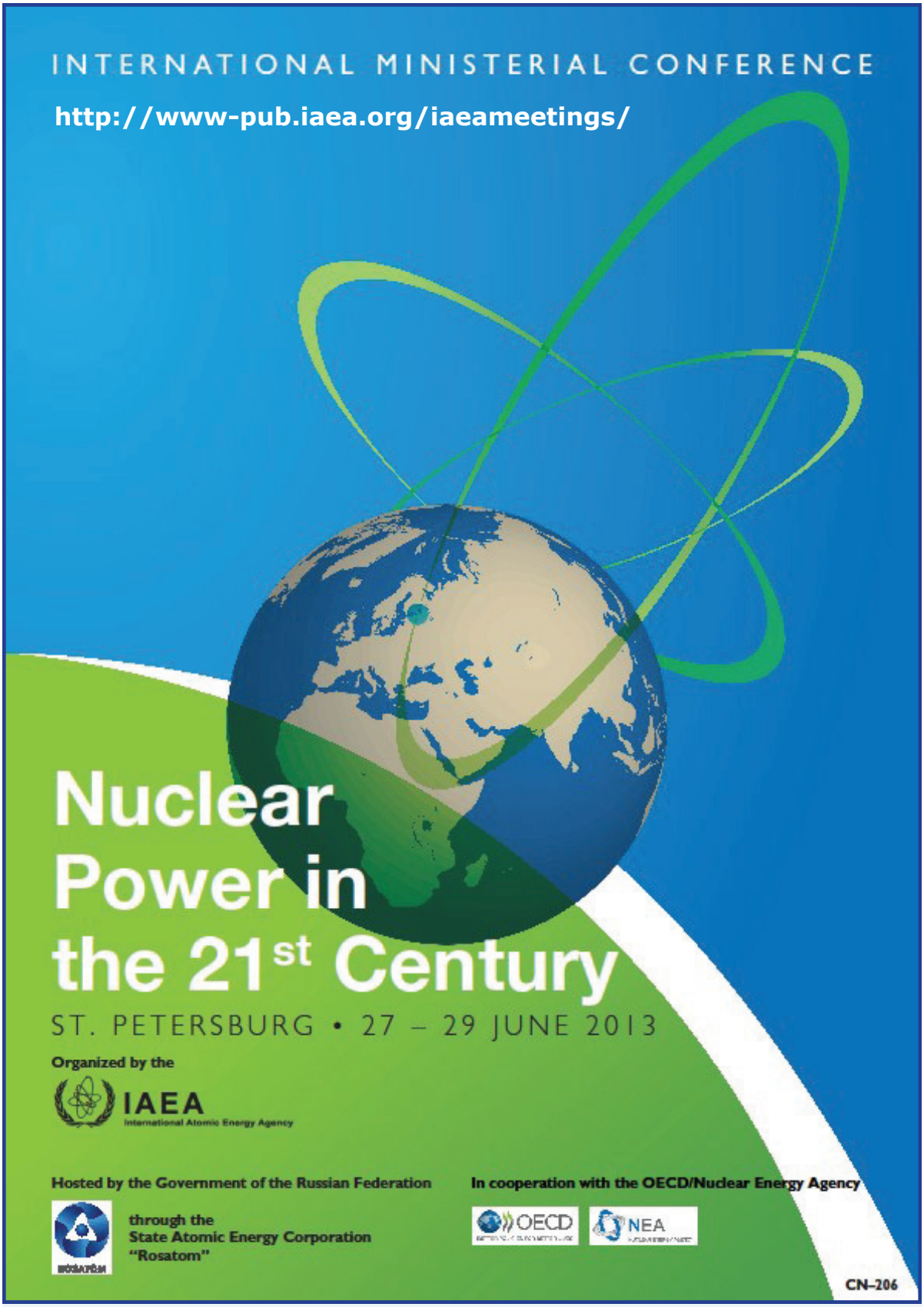
Terracina is located in a beautiful and romantic inlet between the Promontory of Circeo and the Point of Gaeta. The long beaches and the Mediterranean colours have fascinated many poets on their travels over the centuries. Today, Terracina welcomes visitors from all parts of the world, especially in the summer when tourists nearly double the number of local inhabitants (45,000) to enjoy the beaches and the clear sea.

Terracina offers many gastronomic products typical of the Mediterranean area. Wine production is popular, including white wines such as Terracina *Muscatel* and *Passito* of Terracina. This is an extremely sweet wine that was recently named the best *passito* in the world, in a competition held in France.

Since Terracina is located at the seaside, fishing is an important occupation. In the middle of July, the town people, together with the fishermen, celebrate the festival of *Madonna del Carmine*, considered to be the protector of fishermen.

Another festive event is the night of *Ferragosto* on August 14. The people of Terracina and thousands of tourists spend the whole night on the beach, swimming at midnight and admiring fireworks that are lighting the sky.

Antonio Toti is a nuclear engineer in the Nuclear Power Technology Development Section.



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