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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 22751
Fax: +43 1 2600 29598
Email: I.Khamis@iaea.org

International Conference on Human Resource Development for Introducing and Expanding Nuclear Power Programmes

Over 300 people from 62 countries and 11 international organizations attended this conference which was held from 14-18 March 2010 in Abu Dhabi, United Arab Emirates (UAE). Mr. Chidambaran (Principal Scientific Adviser to the Government of India) and Mr. Dale Klein (Commissioner, US Nuclear Regulatory Commission) were keynote speakers for the opening session. The conference took place at the Yas Marina Circuit, site of the first Abu Dhabi Formula 1 race in 2009. The welcome banquet hosted by the UAE was held on a terrace overlooking the Formula 1 arrival grid. The conference stressed the importance of including more women in the nuclear workforce, as a key talent that is still underutilized. The above photo shows a part of the panel that discussed the current situation and best practices in different countries, and potential solutions for some of the issues.

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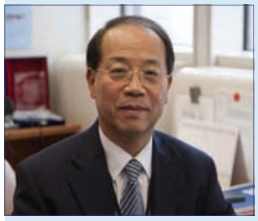
Message from the Director



Welcome to the June 2010 Newsletter of the Division of Nuclear Power. I hope every reader survived the very weird spring weather and Icelandic volcano eruption. This kind of chaos reminds me again that nuclear power would be the only alternative energy source to mitigate the global climate change in the near future.

There were many events over the last quarter, as in the previous years. Among them, the biannual GIF/IAEA-INPRO coordination meeting which was held in Vienna in early March 2010 with a great number of GIF members participating. Topics of common interest were discussed such as methodologies, economics, information exchange, proliferation resistance/physical protection, non-electric applications, collaboration on topical studies, and others. One of the outcomes is a joint workshop on Fast Reactor Safety Issues which will be held in Vienna on 23 to 25 June 2010. A couple of Integrated Nuclear Infrastructure Review (INIR) missions scheduled in the first half of 2010 were postponed to the later part of the year, due to various reasons.

Starting with this Newsletter, there will be introductions to home towns of three NENP staff members. It will take five years to have all the staff introduce their home towns! In this issue, Ms Brenda Pagannone from Italy, Mr Atam Rao from the USA, and Mr Andriy Korinny from Ukraine are presenting their home towns.

Mr Thomas Mazour who has been working on Human Resource Development is leaving us at the end of June 2010 after many years of excellent services. I would like to thank Tom for his great contribution to the IAEA and the Member States. All of us will miss him so much. I wish Tom and his family all the best and good health.

Jong Kyun Park
J.Park@iaea.org

Lessons Learned through 14 years as an IAEA Staff Member

I came to the IAEA in 1995, and for 14 of the past 15 years I have been a staff member in the Division of Nuclear Power. What attracted me to a position with the IAEA was the chance to make a difference and opportunities to expand my knowledge about how to develop and sustain a nuclear power programme.

Looking back, I haven't been disappointed. After having a lead role in over 100 activities while at the IAEA, I found last week upon completion of a workshop that I still took the same satisfaction at the end of that event as I did for my first in 1995. I was asked to provide a brief article based upon this experience. I decided that the most effective way to do this was through sharing the two questions that I've come to ask participants at the end of the IAEA activities for which I have the lead role:

- What did you learn from participating in this activity that you plan to take back and use in your organization?
- What suggestions do you have to make our work more relevant/useful for you and your organization?

Why do I ask those questions? The first question helps me to collect information to judge the impact of the activity from the customer's perspective. Answers to the second question help to identify ways to continually improve how we (the IAEA) carry out our work.

For external readers of this newsletter, my message to you is to get involved in IAEA activities. I assure you that you will gain from this experience; both for your own development and for the benefit your country/organization; not just learning about the IAEA but also about cultures and approaches in other parts of the world. There are a variety of possibilities; to be a participant in a workshop, to help to draft an IAEA document, or to participate in an IAEA expert mission. Being a subscriber to this newsletter is one good way to stay informed, as it provides information on both planned activities and contact points in the IAEA.

In closing, I leave with the thought below. Someone who was very helpful in my career emphasized it often. I've found it to be a useful lesson:

"There is no limit to what can be accomplished if it doesn't matter who gets the credit".

Thomas Mazour

International Conference on Access to Civil Nuclear Energy

In his speech at the *International Conference on Access to Civil Nuclear Energy* on 8th and 9th March 2010 in Paris, France, IAEA Director General Mr. Yukiya Amano emphasized the Agency's role in assisting Member States which are interested in nuclear power. He stressed the importance of introducing nuclear power knowledgeably, profitably, safely and securely, both at the conference and in an opinion article published in *Le Monde*.

Mr. Yury Sokolov, Deputy Director General and Head of the Department of Nuclear Energy, moderated a roundtable on the responsible development of nuclear energy and its appropriate framework. In his opening speech, he underlined the principles, the elements and the international components of a responsible use of nuclear power, as well as the IAEA's activities to support countries accessing nuclear power.

The conference was hosted by the Organization for Economic Cooperation (OECD) Nuclear Energy Agency (NEA) and the French Government. It drew together heads of government, international organizations and industry to promote the peaceful and responsible use of nuclear power. Information available:

http://www.iaea.org/NewsCenter/Statements/2010/amsp2010n002.html

Contacts: AGodard@iaea.org and AStarz@iaea.org

Support to Nuclear Power Plants

New Coordinated Research Project (CRP) on: Beyond 50 or 60 Years, Operations of Nuclear Power Plants

The IAEA has started a new CRP on Beyond 50 or 60 Years, Operations of Nuclear Power Plants. Although the need will be slightly different from country to country, the global demand for electricity is expected to double by year 2030. Moreover, the first term of life extensions from 30 to 60 years for existing nuclear power plants (NPPs) will expire by the middle of this century. In order to cope with this rapidly growing demand for electricity and the potential retirement of the current NPP fleet, many countries are now considering all possible countermeasures, including the construction of new NPPs and extending the lifetime of existing facilities to 80 years.

The overall objective of the CRP is the establishment of quantitative evaluation methodology for continued operations beyond 50 or 60 years in NPPs. The results of the CRP will be used in assessing the safe long term operation of passive systems, structures and components (SSCs), management of age-related degradation issues, and application of new technologies for monitoring, diagnostics, and performance prediction. This will substantially contribute to better technical support of NPP operation safety and life management for long term operations (LTO).

The CRP's goals will focus on:

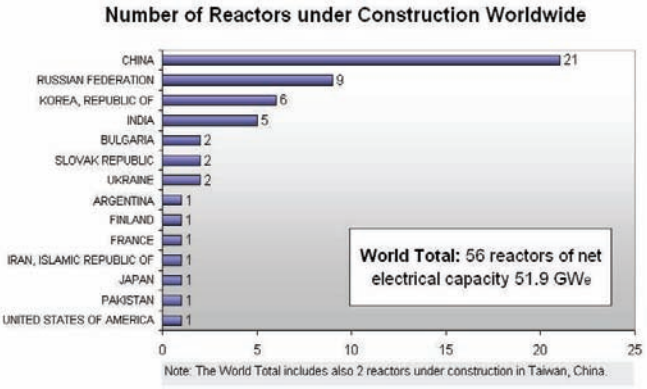
1) Identifying broadly defined research areas that address long-term challenges to plant operations
2) Developing prioritized research areas and identifying cross-cutting topics of relevancy
3) Establishing responsible organizations and their research areas
4) Compiling research results and advising on resolutions to each main topic
5) Incorporating relevant information from related ongoing international activities

The first Coordinated Research Meeting will be held in Mumbai, India in November 2010. Interested organizations are advised to visit the following website to download the proposal and submit it to the Agency: http://www-crp.iaea.org/html/rifa-showapprovedcrp.asp

Contact: K-S.Kang@iaea.org

Project Management including Nuclear Power Plant Construction

At end of 2009, there were 436 nuclear power reactors in operation, with a total capacity of about 370 GW(e) (see Fig below). Fifty-six reactors were under construction, the largest number since 1992. In 2009, construction started on eleven new nuclear power reactors, the largest number since 1987, and projections of future nuclear power growth were once again revised upwards.



Number of reactors under construction worldwide
(ref : PRIS data base)

Current expansion, as well as near and long term growth prospects, remain centered in Asia. Of the eleven construction starts in 2009, eleven were in Asia. Thirty-seven of the 56 reactors under construction are in Asia.

The IAEA has started to develop the guidance on project management, including construction, in nuclear power plants. The guidance is intended to address all relevant issues related to construction management and interface with nuclear power plants and to introduce international good practices in the construction of nuclear power plants, as currently applied in Member States, which will enable commissioning to proceed safely and with a high degree of quality. The report will build on and update the Technical Reports Series No. 279, *Nuclear Project Management – A Guide Book*. The first consultants meeting was held 6-19 February 2010, in Vienna. The new report will reflect the following focal points:

- Construction management approaches for prospective owner organizations, in countries which are starting their nuclear programmes by embarking on their first nuclear power project under a turnkey contractual approach, and the split package approach.
- Define and explain owners' duties in preparatory and execution phases, including construction.
- Advanced construction scheduling methods and approaches that have taken place in the past 25 years, especially in the computer technology.
- The technical meeting will be held in Shanghai, China from 28-30 June, at a nuclear power plant construction site. About 15 experts will participate in the technical meeting.

Contact : K-S.Kang@iaea.org

International Workshop on Project Management for New Nuclear Power Projects

The IAEA organized an interregional workshop on Project Management for New Nuclear Power Projects from 10-15 May 2010, at the Korea Nuclear Power Education Institute (KNPEI), Ulsan, Republic of Korea. A total of 46 participants from 23 countries and one international organization participated in the workshop. The workshop presented, in an integrated manner, issues related to advanced reactor technology, plant construction technologies and plant construction management for new nuclear power programmes and first projects. It addressed several issues in a sequential order as encountered by a Member State starting a new programme. These included:

- Considerations for reactor technology assessment.
- Nuclear power plant construction management.
- Nuclear power plant construction technology.

Installation of reactor pressure vessel in Atuch II, Argentina

Visits by participating scientists to an NPP and radioactive waste facility construction site aided in identifying recent experiences, the relevant factors and approaches influencing improvements in the above topics, and to help develop long-term strategies.

Contacts: K-S.Kang@iaea.org and S.Bilbao@iaea.org

Independent Engineering Review of I&C Systems (IERICS) Missions

Two consultants meetings were held in Vienna, in January and May, respectively, to define the terms and format of mission reports and to develop an NE Guideline Brochure for preparing and conducting IERICS Missions. The scope of the brochure includes the description of activities to be undertaken by the Team Leader and Team Members during the preparation, implementation, reporting, and follow-up of the IERICS missions.

The guidance is also useful to the Counterpart Organization (host of the IERICS mission) in order for them to make the necessary review document preparations and arrangements for the IERICS mission. The first review mission took place in Seoul, Republic of Korea in February 2010, and it reviewed the prototype of Doosan's advanced digital I&C systems designed for APR-1400 NPP to be implemented first in the Shin-Ulchin Unit 1&2 Project. The next IERICS mission will be in Ukraine, to review the FPGA-based digital I&C systems for the reactor protection, control, and monitoring functions installed in Ukrainian NPPs.

Challenges in I&C Modernization Projects and New Designs

A consultant meeting and a TC Europe Region Workshop were held in May 2010 focusing on current challenges and resolutions in designing, implementing, testing, licensing, and operating modern I&C systems in NPPs, including consistent compliance of licensing digital I&C systems and equipment in NPPs. A related document is under development whose objective is to highlight solutions to technical challenges, the major

critical issues and what options along with associated existing precedents are available today in resolving these problems. The related benefits and challenges of each option will also be presented, along with existing solutions and measures in various countries. The final objective is to have the industry and the regulatory bodies move toward a more global common position on these technical issues providing the industry the confidence to move forward with improved designs for both existing and new plants.

NE-ICT Network of Excellence

A consultants meeting was held in Vienna on 12-15 April to develop a formal Terms of Reference for the experts' network titled Network of Excellence for Supporting the Use of I&C Technologies for the Safe and Effective Operation of NPPs (NE-ICT). The meeting also discussed the experience of similar networks already operating in the Nuclear Energy Department. Available software tools and various modes of network operation were also considered. In addition to the I&C area, similar networks will be set up for other technical areas of the Division of NENP, such as plant life management, human resources development, and construction and commissioning activities in NPPs.

Coordinated Research Programme (CRP) Surveillance, Diagnostics, and Prognostics in NPPs

The 3rd Research Coordination Meeting on the CRP titled Advanced Surveillance, Diagnostics, and Prognosis Techniques used for Health Monitoring of Systems, Structures, and Components in NPPs will be held in Richland, Washington, USA, to be hosted by the Pacific Northwest National Laboratory (PNNL). The meeting will further develop the final draft of the CRP report and will evaluate the results of various benchmark analyses.

Integration of NPPs into Electric Grids

A National Training Course was held in Tunis, Tunisia, on the subject of integrating NPPs into the electric grid. Work is also underway to further develop the NE Series Report titled Electric Grid Reliability and Interface with NPPs, and a brochure titled Elements to Determine the Integration of NPPs into Electric Grids. A Technical Meeting on the subject is scheduled for 3-6 August 2010 in Vienna.

Contact O.Glockler@iaea.org

Support to Infrastructure

Workshop on Topical Issues in Infrastructure Development

The fourth annual Workshop on Topical Issues in Infrastructure Development was held from 9–12 February 2010, with more than 100 participants from 47 Member States and two International Organizations. This Workshop provides a valuable opportunity for exchange of information and to facilitate the development of a national infrastructure for Nuclear Power. The Chairman, Mr W. Rasin, concluded that this workshop was the most successful to date in the IAEA's continuing series on infrastructure development. Participation was excellent and the breakout sessions, where participants from newcomer countries discussed on their experiences and lessons learned, were particularly profitable and appreciated.

Workshop on Topical Issues in Infrastructure Development
IAEA, 9–12 February 2010

The key issues faced by all countries embarking on a nuclear power programme are developing a national strategy, Human Resource development, Safeguards, and Security. These topics, as well as the assistance available from the IAEA and perspectives from NP vendors, were all covered during the workshop. A keynote speech on Chile's strategy used during introduction of NPP was delivered by their Minister of Energy.

The participants from both newcomer and experienced countries presented their experiences in a very honest manner. Particularly beneficial, the newcomer countries shared information not only on good practices, but also on gaps identified. Lessons learned by countries embarking on a new NP programme are valuable for both newcomer countries and their supporting partners.

Major conclusions were:

- More assistance requested from the IAEA, in particular during Phase 1.
- The responsibilities of vendor countries were underlined. If developed nations continue to encourage the adoption of NP, they should feel obligated to support newcomer countries.
- The major decision in Phase 1 is an economic, social and political decision. The political will and governmental commitment must come from the Member State itself.
- The importance of honest self evaluation, to help identify shortcomings and improve the NP Programme.

The next annual workshop is planned early next year.

Contact: A.Starz@iaea.org; M.Aoki@iaea.org

Planning for Industrial Involvement and Technology Transfer for Nuclear Power

One of the major areas of concern in development of a nuclear power program is a viable national industrial infrastructure. This is a concern even in countries constructing plants on a "turn-key" basis, which generally provide little opportunity for domestic industries to participate in the construction. Many commodities, components and services are required to construct and operate a nuclear power plant. Also needed are industrial organizations that can comply with strict codes and standards, and maintain rigorous quality programmes.

In response to Member States increased interest in developing domestic industry while introducing nuclear power, the IAEA is writing an NE Series publication. In support of this publication, a 2nd Consultants Meeting was held in Vienna from 29 March to 01 April 2010. Specialists in Nuclear Power, Supply Chain, Technology Transfer and Intellectual Property met to plan what would best meet the Member States' needs.

A technical meeting will be convened from 6-9 September 2010 at the IAEA headquarters in Vienna. This meeting will provide a technical forum on nuclear power industrial capacity building and technology transfer, and will be another opportunity for participants to contribute to this IAEA Publication.

Contact: V.Nkong-Njock@iaea.org, M.Aoki@iaea.org

INPRO

The 4th GIF-INPRO Interface Meeting

International cooperation is one of the hallmarks of INPRO. To that end, INPRO is also cooperating with other international initiatives concerning developments in nuclear technology to ensure good synergy of activities and avoid duplication of efforts. A key partner in this mutually beneficial collaboration is the Generation IV International Forum (GIF). Recognizing the complementary nature of their programmes, i.e. contributing to the sustainable development of nuclear energy in the 21st century, INPRO and GIF have been holding regular

Opening of the GIF-INPRO Interface meeting, held 1-3 March 2010 at the IAEA; from left: R. Beatty, INPRO Group Leader, Y. Sagayama, Chair of GIF, Y. Sokolov, DDG-NE, J.K. Park, DIR-NENP, H. Forsstroem, DIR-NEFW

interface meetings since 2004.
The fourth such meeting took place at the IAEA this spring. Over 50 representatives from GIF, including the GIF Chair Y. Sagayama and GIF Technical Director H. McFarlane, INPRO and other IAEA programmes came together on 1-3 March 2010 to share information on progress of activities and discuss future plans related to technology innovation of nuclear energy systems, monitor the progress of cooperation as agreed in a Memorandum of Understanding (MoU) of February 2008, and develop a Joint Action Plan with new areas of expanded cooperation.

GIF selected six nuclear energy systems for further study and development: gas-cooled fast reactor (GFR) very-high-temperature reactor (VHTR), supercritical-water cooled reactor (SCWR), sodium-cooled fast reactor (SFR), lead-cooled-fast reactor (LFR) and molten salt reactor (MSR). These six systems employ a variety of reactor, energy conversion and fuel cycle technologies. Their designs feature thermal and fast neutron spectra, closed and open fuel cycles and a wide range of reactor sizes from very small to very large. Depending

on their respective degrees of technical maturity, the Generation IV systems are expected to become available for commercial introduction in the period between 2015 and 2030 or beyond.

A report on **INPRO's progress status** focused on the programmatic areas identified in the INPRO Action Plan 2010-2011, i.e. Nuclear Energy System Assessments (NESAs) using the INPRO Methodology; Global Vision, Scenarios and Pathways to Sustainable Nuclear Development; Innovations in Nuclear Technology and in Institutional Arrangements and the INPRO Dialogue Forum on Nuclear Energy Innovations.

Safety, proliferation resistance, economics and non-electrical applications of nuclear energy had been identified earlier as issues of common interest, since they are addressed by both GIF and IAEA programmes. Progress to date and the current status of activities were reported in areas such as application of IAEA Safety Standards to advanced/future reactors and an evaluation methodology developed by the GIF Risk and Safety Working Group; the GIF proliferation resistance and physical protection methodology (PRPP) and assessing proliferation resistance with the INPRO methodology; the GIF economic model and economic assessments of the IAEA's Planning and Economic Studies Section (PESS) and INPRO, and IAEA and GIF activities in non-electrical applications of nuclear energy.

Expanding Cooperation: A major discussion item was potential areas of future cooperation, in particular modelling and simulation, advanced small and medium sized reactors, advanced fuel cycles (including the thorium fuel cycle), advanced reactor development (including supercritical water cooled reactors, high temperature gas cooled reactors and fast reactors), advanced and innovative materials development, education and training programmes and institutional arrangements for the deployment of innovative concepts, in particular the infrastructure necessary to optimize benefits from using advanced nuclear systems including fast reactors.

All programmatic areas of INPRO received GIF support; in particular, synergies were identified with GIF activities in the areas of NESAs, Global Vision, Innovations and the INPRO Dialogue Forum. It was agreed that GIF members would contribute to those INPRO Collaborative Projects (CPs) and IAEA Coordinated Research Projects (CRPs) that complement GIF's specific interests. GIF representatives also would be supporting the INPRO Dialogue Forums as technology holders.

One of the interface meeting's outcomes was the decision to jointly hold a series of workshop on sodium cooled fast reactors. In a preparatory session, representatives from India, Japan, the Russian Federation and the USA presented their national programmes.

Topics to be addressed in the workshops include reactor safety issues, economic aspects and construction and operational experiences. The first such workshop, Safety approaches and priorities for advanced sodium cooled fast reactors will be held at the IAEA Headquarters, on 23–24 June 2010. A. Stanculescu (IAEA/NPTDS) will serve as Scientific Secretary in cooperation with R. Beatty, INPRO Group Leader and H. McFarlane of GIF.

GIF Briefing for IAEA Staff

Following the GIF/INPRO interface meeting, all interested IAEA staff members had the opportunity to attend a technical information session on the outcome of the GIF-INPRO Interface Meeting and the current status of GIF's activities. GIF Technical Director H. McFarlane briefed an attentive audience of over 120 staff on the background, technical scope, the status of Generation IV systems and future challenges to be addressed.

GIF was established in 2001 to lead the collaborative efforts of the world's leading nuclear technology nations to develop next generation nuclear energy systems to meet future energy needs. Its current membership is comprised of Argentina, Brazil, Canada, China, France, Japan, the Republic of Korea, the Russian Federation,

The IAEA Library hosted a GIF-INPRO Technical Briefing Session on 3 March 2010

South Africa, Switzerland, the United Kingdom, the USA and Euratom. More information and all presentations of the GIF-INPRO Interface Meeting are available at: http://www.iaea.org/INPRO/2010-Mar-GIF.html

Contact: R.Beatty@iaea.org

Strategic Partners: Belarus and Russian Federation Cooperate on NESA

INPRO is facilitating effective cooperation among its members. One such example is a scientific visit, which the Russian Federation hosted for a team of experts from Belarus in April 2010. The two-week visit was part of the Belarusian Nuclear Energy System Assessment (NESA) project which the country is undertaking in collaboration with the Russian Federation.
Four Russian institutions were on the schedule of the Belarusian NESA team led by Boris Popov of the Joint Institute for Power and Nuclear Research (SOSNY) in Minsk: Atomenergoproject in St.Peterburg, Gidropress in the Podolsk Moscow region, the Institute of Physics and Power Engineering (IPPE) in Obninsk, and the Kurchatov Institute in Moscow. Lectures, demonstrations, round table and other discussions at each of the host institutions enabled the Belarusian team to enhance their knowledge and expertise in specific technical areas relevant for undertaking a NESA using the INPRO methodology, to study examples of good international practices in developing and managing nuclear power programmes and to benefit from the experience of their Russian colleagues. The Russian Federation is the vendor for the first Belarusian nuclear power plant, and a likely supplier of fuel cycle services. The first unit of the Belarusian NPP is scheduled to be commissioned in 2016.

Contact: A.Korinny@iaea.org

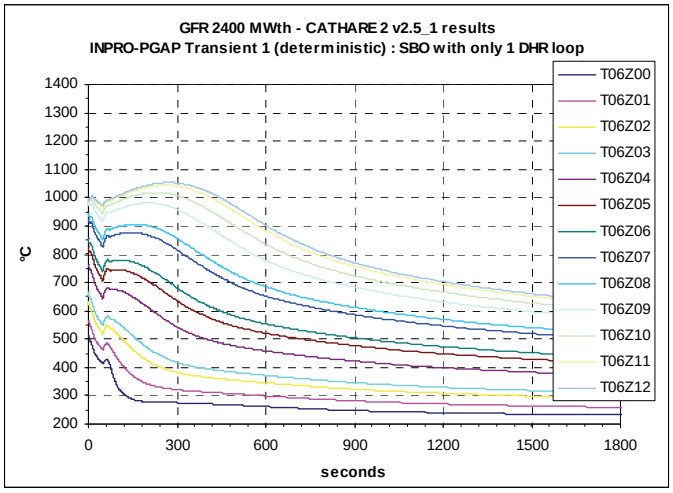
Performance Assessment of Passive Gaseous Provisions (PGAP)

Innovative reactor concepts often include increased use of passive systems to enhance safety. The lack of operating experience and data covering phenomena of relevance to passive safety systems over a wide range of operating conditions may cause design challenges. Several methodologies have been developed to assess the performance and reliability of such systems. These methodologies have different features and employ different definitions for reliability.

The objective of the INPRO Collaborative Project on PGAP is to contribute to an international consensus in two areas: 1) a unified definition of the reliability of a passive system that involves natural circulation, and 2) a unified methodology to assess this reliability.

This project considers two methodologies developed in Europe (Reliability Methods for Passive Systems (RMPS)), and in India (Assessment of Passive Systems Reliability (APSRA)), and will use the results of a benchmark exercise that models decay heat removal transients for the CEA gas cooled fast reactor (GFR) design. This benchmark exercise is comprised of two phases — deterministic calculations and reliability calculations. For each phase, two transients will be simulated to assess the performance of the decay heat removal system. These transients include a station blackout (SBO) event, and a 3-inch diameter loss of coolant accident (LOCA) event.

The deterministic analyses for the first transient (station black-out) were completed recently and presented at **the third technical project meeting** (February 2010 in Cadarache, France) using two different computer codes (RELAP and CATHARE). In addition, sensitivity studies were performed and agreement was reached between the participants on the critical parameters that will be used in the reliability analysis phase using the RMPS and APSRA methodologies. This phase is ongoing and will be followed by a repeat of the calculations for the second transient. The outcome of this project will provide insight into both the RMPS and ASPRA assessment methodologies, highlighting key aspects that can be used to arrive at a common assessment methodology for passive safety systems that utilize natural circulation.



Sample predictions from Transient 1 (fuel clad temperature as a function of time at different core elevations)

In addition to France (Commissariat à l'énergie atomique - CEA), which initiated and is now leading the PGAP project, institutions in Belarus (SOSNY), Belgium (SCK-CEN), Czech Republic (NRI-Rez), Germany (FZK), India (BARC) and Algeria (COMENA) are contributing to this project.

See also: http://www.iaea.org/INPRO/pgap.html

Contact: H.Khartabil@iaea.org

Investigating the U-233/Thorium Fuel Cycle (ThFC)

Under INPRO, experts in Member States are looking at the possibility of using thorium-based fuel cycles to help achieve sustainable nuclear energy in the 21st century. The Collaborative Project (CP) on Further Investigations of the U233/Th Fuel Cycle is re-examining this issue and will report its findings in an IAEA document at the end of the year. At the early stage of the project an information system with some three hundred publications on thorium utilization was created and initial data for scenario calculations were compiled.

In late March 2010, participants in this CP from Canada, France, Germany, India, the Russian Federation, Ukraine and the EC's Joint Research Centre met at the IAEA to review progress to date, and in particular harmonize scenarios for introducing thorium fuel cycle options, based on material flow and reactor data from Member States. For example, India provided a set of material flow and reactor data of AHWR in a once-through fuel cycle with advanced characteristics, while France presented new data on introducing thorium as fuel in operating LWRs. Also, CP participants carried out physics calculations and scenario studies that so far have not been covered in IAEA publications. Studies on reactor experiments and fuel manufacturing undertaken in several Member States were presented.

The project participants also discussed issues of proliferation resistance, such as the influence of gamma irradiation of U-232 daughter-products, and agreed to work closely with experts of the IAEA Department of Safeguards when reporting related findings.

The project results and recommendations on using thorium as a supplementary nuclear fuel resource will feed into other INPRO studies, such as the INPRO GAINS project (Global Scenarios and Regional Trends of Nuclear Energy Development in the 21st Century) and the planned INPRO activity of developing a global vision on a sustainable nuclear development.

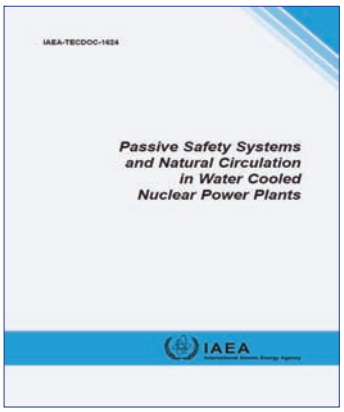
Experts engaged in the scenario study are considering now a related activity to estimate basic economic parameters of the thorium fuel cycle, with the aim of initiating a new study on the establishment and maintenance of a reliable database of economic parameters of nuclear energy systems, to be conducted within the framework of INPRO.

See also: http://www.iaea.org/INPRO/thfc.html

Contact: A.Korinny@iaea.org

Technology Development of Nuclear Reactors

Passive Safety Systems and Natural Circulation in Water Cooled Reactors

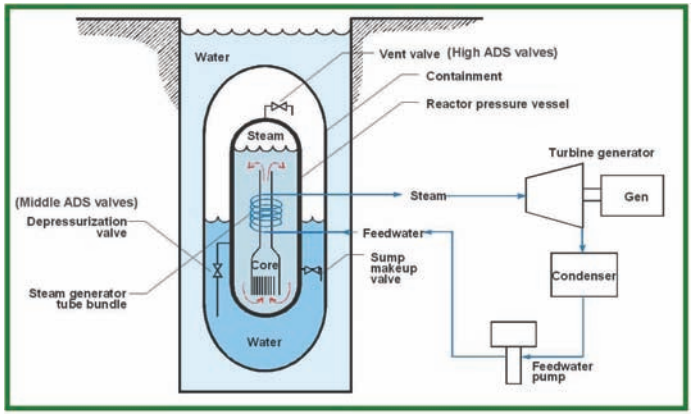


Passive safety systems are becoming an important component in advanced reactor designs. This has led to an increasing international interest in examining natural circulation phenomena as this may play an important role in the operation of these passive safety systems.

The IAEA has organized a coordinated research project (CRP) on Natural Circulation Phenomena, Modeling, and Reliability of Passive Systems That Utilize Natural Circulation. Within the frame of this CRP a document entitled ***Passive Safety Systems and Natural Circulation in Water Cooled Nuclear Power Plants (IAEA-TECDOC-1624)*** was published recently. This document includes the survey on passive safety systems adopted in advanced water cooled reactors and thermal hydraulic phenomena involved in each passive safety system. Twenty reference advanced reactor designs including evolutionary and innovative designs were selected to examine the use of natural circulation and passive systems in real nuclear power plants.

Natural Circulation in Integral PWR

Most advanced water cooled reactors incorporate several kinds of passive systems based on natural circulation. The integral PWR concept, which contains the nuclear steam supply systems within the reactor vessel, is one of the innovative reactor types with good chances for deployment. The new 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 prepared as a follow-on to the CRP on Natural Circulation Phenomena, Modeling and Reliability of Passive Systems that Use Natural Circulation. Oregon State University (OSU) has offered their experimental facility, which was built to demonstrate the feasibility of MASLWR design, and fourteen institutes from seven Member States have indicated their interest for this ICSP. The scope of the ICSP includes two types of experiments: 1) single and two phase natural circulation flow stability test with step-



Schematic of the Oregon State University experimental test facility

-wise reduction of primary inventory, and 2) loss of feed water transient with subsequent ADS blowdown and long term cooling by primary-containment coupling. The ICSP will be conducted in three phases: double-blind (with designed initial & boundary conditions before the conduction of the experiment), blind (with real initial & boundary conditions after the conduction of the experiment) and open simulation (with real experimental data after the conduction of the experiment). The first workshop was held at OSU, USA in March 2010. Test procedures and initial & boundary conditions for planned experiments were discussed and agreed by participants during the first workshop. China, India, Italy, Rep. of Korea, Russian Federation, United Kingdom, and the USA are participating in this ICSP.

Contact: J.H.Choi@iaea.org

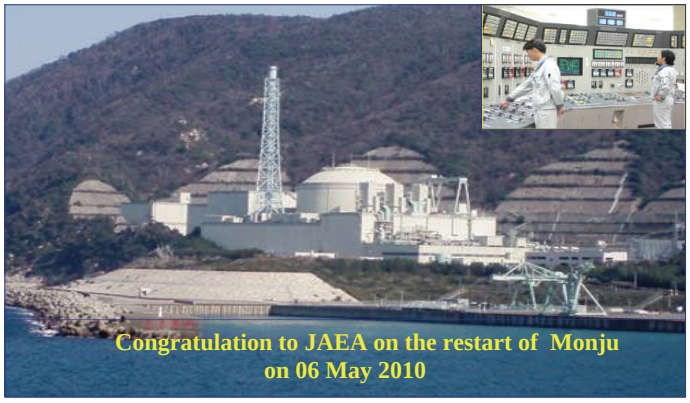
Technologies and Issues for SMRs

Research results of the IAEA coordinated research project (CRP) on Small Reactors without On-site Refueling will be published soon. Another publication titled Evaluation of Human Resource Needs in Conjunction with New NPP Build – Armenian Case Study is under compilation. This publication provides detailed, spread over time, evaluations of staffing requirements at all stages of a new NPP build, starting from pre-preparatory activities and ending with plant operation, and will also highlight how these requirements could be affected by the selection of technological options.

Within the ongoing CRP on Development of Methodologies for the Assessment of Passive Safety System Performance for Advanced Reactor, a programme of tests has been defined which would support validation of the common analysis-and-test based method developed for the purpose of this CRP. The tests will be performed at the L2 natural circulation loop located at the Genoa University of Italy and taken care off by a research team from the University of Pisa (Italy). The tests will be performed within a parameter range representing the boundary between stable and unstable loop operation. A revised version of the software for comparative economic analysis of deployments of a larger number of SMRs versus fewer larger reactors is currently under joint verification by the Politecnico di Milano (Italy) the IAEA's INPRO project. More details about this model, called Integrated Model for Competitiveness Analysis of SMRs – INCAS could be found at: http://www.iaea.org/NuclearPower/SMR/.

Contact: h.subki@iaea.org

Technology Development for Fast Reactors and Accelerator Driven Systems



After 14 years of continuing shutdown, JAEA has just restarted the sodium cooled fast breeder reactor on 06 May 2010 where the first criticality took place just 2 days later. Indeed, this is a remarkable achievement and an additional tangible sign that fast reactor development is back on the agenda of research centers, industry, and academia around the world.

Some countries are in the construction phase of fast reactors, whereas others are considering earlier development and deployment of these systems to address efficient resource utilization for electricity production and/or waste minimization.

In line with its mandate (Charter), the IAEA facilitates collaborative R&D activities and information exchange in these areas. The IAEA Project on Technology Support for Fast Reactor Mid Term Deployment is relying on the IAEA Technical Working Group on Fast Reactors (TWG-FR) as an advisory and planning body, as well as an implementation framework.

Based on the advice and on the needs expressed by these Member States, and thanks to the leverage offered by the R&D&D programs being implemented in the TWG-FR Member States, the Project is (i) sustaining the excellent platform for the fast reactor specialists to share the experience related to design, development, construction and operation of nuclear power plants with fast reactors, (ii) organizing regular topical technical meetings to exchange information, (iii) pro-active in the organization of large conferences on different aspects of

fast reactor research and technology, (iv) establishing a forum for broad exchanges on technical requirements for 4th generation fast reactor systems, (v) carrying out Coordinated Research Projects (CRPs) of common interest, (vi) providing technical expertise/support to the IAEA Nuclear Safety Department with the development of fast reactor safety standards, and (viii) securing training and education in the field of Fast Neutron System Physics, Technology and Applications and organize respective Schools and/or Workshops on a regular basis.

The Project emphasizes the following areas in which it can make an impact, have a positive outcome for, and provide added value to Member States activities:

- Modelling and simulation of various phenomena (neutronics, thermal hydraulics, thermal mechanics) relevant to fast reactor R&D and core design. These activities are contributing towards meeting the needs of the Member States in the area of data and computer code verification, validation, and qualification (V&V&Q) with the help of theoretical and experimental benchmark exercises, including severe accident analyses.
- Planning, development and realization of fast neutron spectrum experimental (irradiation) facilities, as well as the planning and implementation of experimental programmes at such facilities. Without such facilities, fast reactor R&D&D is not possible, and international collaboration is expected by all players.

At the 43rd Annual Meeting of the TWG-FR (hosted by SCK·CEN, Mol, from 17 – 21 May 2010 in Brussels, Belgium), the TWG-FR members discussed and agreed upon the detailed strategy and common activities for the timeframe of the P&B 2011 – 2012 and beyond. More information at:

www.iaea.org/inisnkm/nkm/aws/fnss/index.html

Contact a.stanculescu@iaea.org

Non-Electric Applications of Nuclear Power and Water Implications

Recently, a large number of Member States have shown increasing interest in nuclear power. This comes back into focus during debates on energy generation, often in relation to wider issues such as global warming and climate change. Accordingly, various estimates show that between 447 GW and 691 GW of electricity may be generated by nuclear power in very near future, say beyond 2030. Crucial factors may well affect this growth such as social, economical and environmental ones. Yet, in a nuclear power plant, water is the vital issue in every one of those factors.

Worldwide, the general trend is that high rates of economic growth would require rapid expansion of electrical generating capacity and thus the rapid development of water resources.

Requiring greater water withdrawal than other types of thermal power plants can make zero emission nuclear power a less attractive option for the major additions to capacity these nations require to support a rising standard of living for their growing populations.

Based on current cooling water requirements of a generic 1000 MW(e) nuclear power plants, units with once-through cooling would require 26-64 m^3/s. These numbers depend on the temperature of the cooling water and the temperature difference with the steam in the condenser, as well as the condenser efficiency. Therefore, lowering water use and consumption have been given attention through different programs considering:

- Higher efficiency (of power conversion):
- Alternative cooling (air-cooling, hybrid cooling and closed loop water cooling).
- Alternative water sources (desalination and water reclamation).
- Alternative technologies that would replace water in some areas.
- Cogeneration as the simplest ways to increase the efficiency and thus reduce cooling needs.

Technological advances in the above mentioned areas can have a positive impact on the attractiveness of nuclear power and its benefits.

The IAEA is taking the lead in preparing a comprehensive publication on the Efficient Management of Water Use and Consumption of Nuclear Power Reactors. The main objective of this publication is to present current water requirements in NPPs, the technologies employed, best practices and strategies for lower water withdrawal rates, as well as to present the trends that are likely to be of interest in the future. The report thus aims at enhancing the understanding of the issues and possibilities regarding nuclear power and water availability.

As water and power are inseparably related, it becomes clear that the availability of one will affect the availability of the other. The optimal choice will require knowledge of the available options. Therefore, this publication is intended primarily for decision-makers, energy and/or water planners, and environmental experts. The publication is expected to be finalized by end of 2010.

Contact: I.Khamis@iaea.org

My Hometown

A new initiative to introduce the hometowns of NENP staff was taken by Division Director Mr. Park. We would like our readers to meet the people working on issues covered in the Nuclear Power Newsletter. Starting in this issue, three staff members will introduce their hometowns.

The Abruzzo Region in Italy

*By **Brenda Pagannone***

"At 12 noon exactly, in an overcrowded piazza, the doors to the sanctuary of the local saint, San Domenico, burst open. A priest lurches forward into the crowd, followed by two girls wearing tall, voluminous hats. The crowd pushes in even tighter, as the wild snake charmers of Cocullo, perform their ancient ritual. The statue of the saint is raised into view. This is the moment when the statue has become a writhing mass of snakes, slithering and coiling around the body of the 900-year-old saint. They hiss and poke their forked tongues at us and the crowd falls silent. Remote and hidden away in the wild mountains of the Abruzzo, only 100km from Rome and yet a world apart, the solid heart of Italy beats to its own timeless rhythm." This is my region, Abruzzo.

Bordered by the Apennines to the west and the Adriatic on the east, Abruzzo has some of Italy's most unspoiled scenery. National parks cover a third of its territory, and contain most of Europe's flora and fauna species. The real charm of the Abruzzo lies in her mountains. The Gran Sasso massif has the highest peak in Italy, almost 3,000 m above sea-level. Standing on top, you have views of both the Adriatic and the Tyrrhenian Seas. The coast is

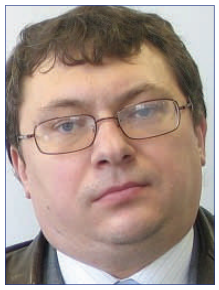
more than 100 km long. There are gentle slopes covered in vineyards for Montepulciano d'Abruzzo wine and wheat fields for the best pasta in Italy. The Romans grew spelt here and carried its water to Rome via massive aqueducts. In Abruzzo, pride is taken in the quality and variety of the local cuisine, most of which are based on peasant dishes. To wash it all down, you can choose from the best wine cellar east of Rome. With a cast of over 500 grape varieties, there are 40 labels of Montepulciano d'Abruzzo alone, a velvet-smooth dry red, you will be able to find one you enjoy.

In 2009, the region was hit by The L'Aquila Earthquake. The earthquake devastated Abruzzo's capital city, many of her surrounding villages, and killed 308 people. But in the spirit of the abruzzesi, known for being 'forti e gentili' (strong and kind people), L'Aquila has applied to become the 2019 European Cultural Capital, and will showcase what European and International cultural co-operation can achieve in rebuilding a shattered city.

__Brenda Pagannone__ works as Junior Professional Officer in the Nuclear Power Engineering Section.

Netishin in Ukraine

*By **Andriy Korinny***



The name of my home town is Netishin, a small town in the western part of Ukraine. Its population is only 36000 people but it is one of the most important industrial centers of the region, in particular because Netishin is the location of the Khmelnitskiy nuclear power plant (NPP).

This is the smallest NPP in Ukraine, which, by the way, also possesses the largest NPP in Europe. The Khmelnitskiy plant is not too small, since the capacity of its two operating units is 2 000 MW(e). Also, two similar units are under construction. The nuclear power plant is the pride of every Neteshiner.

Khmelnitskiy Nuclear Power Plant (Units 1 and 2)

The town of Netishin and its NPP are located in an artificial landscape. Thirty-five years ago, a village surrounded by marshes, swamps and forests lay between two ancient Ukrainian towns, Ostrig and Slavuta, at the right bank of the river Goryn. Construction of the nuclear power plant changed the landscape drastically; the construction site was drained, and a system of channels and beautiful deep lakes was created. The biggest lake is up to 5 kilometres in diameter! Nevertheless, the forests are still there, and pines and fir trees surround the town and the nuclear power plant.

Downtown Netishin; the Khmelnitskiy NPP can be seen in the upper left corner on the horizon

The people who live here are also special; for example, Netishin is the only town in Ukraine where the population grows in a natural way, i.e. through an increasing birth rate and not through immigration. Netishiners are quite advanced in business, culture, and sports. Several World and European champions in wrestling and two gold medal winners in fencing at the Beijing Olympic Games were born and raised here.

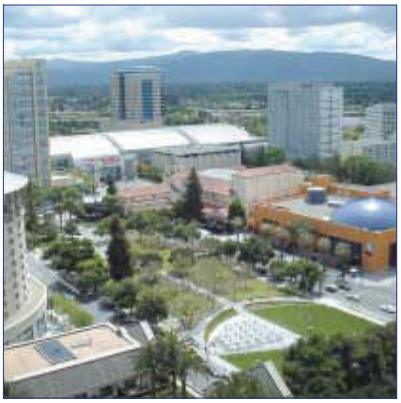
***Andriy Korinny** is a Cost-Free Expert from the Ukraine in the INPRO Group*

San Jose, California

*By **Atam Rao***

My adopted hometown of San Jose, California in the USA has been the place where I worked (at General Electric Company) and raised a family for the last 35 years. I have seen the change in the city over the years – it used to be dotted with orchards of apricots, walnuts, cherries and plums. It is now famous as the Capital of Silicon Valley and is known around the world as a high-tech center with the largest concentration of technology expertise in the world – more than 5600 technology companies.

A city founded in 1777 and the first capital of California, it is now the 10th largest city in the USA with a population of over a million residents, with roots from all over the world. The city has a diverse population equally divided between Hispanics (from Central and South America), Asian origin and European origin residents. What makes this city such a wonderful home is not the fact that it has the highest median household income in the US (probably too many nerdy engineers for some people) but the fact that it surrounded by mountains, is close to the coast and has 300 days of sunshine every year!

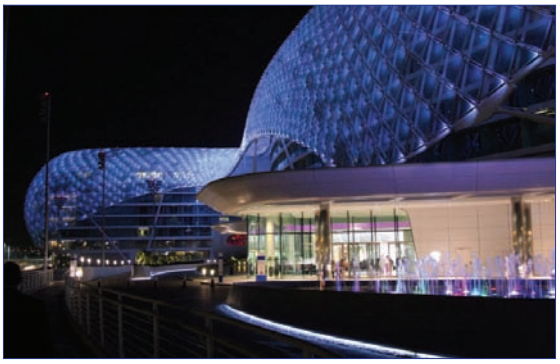


***Atam Rao** is the Section Head for Nuclear Power Technology Section and has been with the IAEA for 4 1/2 years.*

Continued from page 1

International Conference on Human Resource Development for Introducing and Expanding Nuclear Power Programmes

The conference took place at the Yas Marina Circuit, site of the first Abu Dhabi Formula 1 race in 2009. The welcome banquet hosted by the United Arab Emirates was held on a terrace overlooking the Formula 1 arrival grid.



The conference stressed the importance of including more women in the nuclear workforce, as a key talent that is still underutilized. This photo is of part of the panel that discussed the current situation and best practices in different countries, and potential solutions for some of the issues.

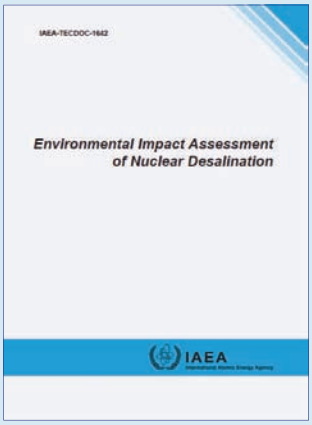
The conference also ran interactive presentations instead of the standard poster presentations. This allowed participants to discuss the papers interactively with a video screen, while enjoying coffee and delicious emirate sweets. This is the area dedicated to the UAE Institute of Applied Technology, a technical education system providing distinctive secondary school programs that integrate career and technical education with a rigorous academic core.

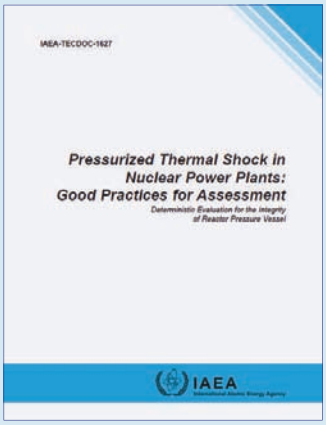
The conference included a considerable number of young nuclear professionals, who ran a panel discussion on the needs and aspirations of the next generation.

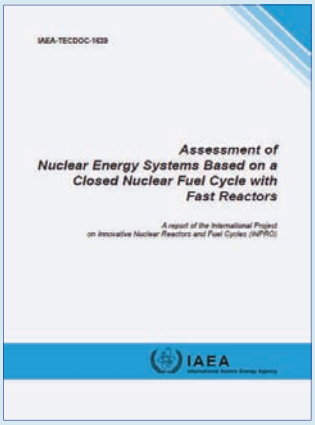
The conference programme and all conference (both plenary and interactive) presentations are available at: http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=38090

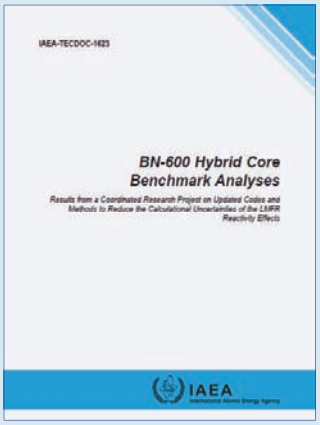
2010 Publications

- ***IAEA-TECDOC-1642 Environmental Impact Assessment of Nuclear Desalination***
- ***IAEA-TECDOC-1639 Assessment of Nuclear Energy Systems Based on a Closed Nuclear Fuel Cycle with Fast Reactors. Report of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)***
- ***IAEA-TECDOC-1623 The BN-600 Hybrid Core Benchmark Analyses***
- ***IAEA-TECDOC-1627 Pressurized Thermal Shock in Nuclear Power Plants: Good Practices for Assessment***









For further details or to download these documents, please visit: http://www-pub.iaea.org/MTCD/publications/PDF

10 Years of INPRO

Celebrated during the 54th IAEA General Conference

20 September 2010, 2:00–2:30 pm, C Rotunda
Festive event to mark INPRO's 10th anniversary

22 September 2010, 3:30–5:00 pm, IAEA Library
Technical session with invited speakers

Technical Lead (Management Systems)

This individual ensures a results-oriented programmatic response to Member States' priorities by organizing training programmes, workshops and Technical Meetings, developing international guidelines and preparing state-of-the-art reports on management systems for operating nuclear power plants and new nuclear power programmes. The Technical Lead (Management Systems) assists Member States by providing, technical assistance on management systems to enhance the efficiency and effectiveness of their nuclear energy programmes.:

http://recruitment.iaea.org/phf/p_vacancies.asp

Contact: p.vincze@iaea.org

Vacancy Notice for Professional Posts

New vacancy notices are available on the IAEA webpage addressing
https://personnel.iaea.org/apps/phflink/p_vacancies.asp.

Applications from qualified women and candidates from developing countries are encouraged.

Upcoming Selected Events

Date	Contact	Title	Venue
3-6 Aug-10	O.Glöckler@iaea.org	Technical Meeting on Interfacing Nuclear Power Plants with the Electric Grid: the Need for Reliability amid Complexity	Vienna Austria
24-28 Aug-10	s.bilbao@iaea.org	RCM of the CRP on Heat Transfer Behavior and Thermo-hydraulics Code Testing for Super-critical Water Cooled Reactors (SCWRs)	Obninsk Russian Fed.
6-9 Sept-10	V.Nkong-Njock@iaea.org	Technical Meeting on Planning for Industrial Involvement and Technology Transfer in NPP Projects	Vienna Austria
14-17 Sept-10	O.Glöckler@iaea.org	Technical Meeting on Assessing and Managing Cable Ageing in Nuclear Power Plants (NPPs)	Halden Norway
4-8 Oct -10	H. Khartabil@iaea.org	Technical Meeting of the INPRO Dialogue Forum on Nuclear Energy Innovations	Vienna Austria
04-05 Oct-10	i.khamis@iaea.org	TM of the CRP on New Technologies for Seawater Desalination using Nuclear Energy	Vienna Austria
19-22 Oct-10	h.subki@iaea.org	TM on the Preparation of a Publication on Innovative SMR Designs with a Potential of Being Deployed by 2010	Vienna Austria
27-28 Oct-10	i.khamis@iaea.org	TM Technical Working Group on Nuclear Desalination	Vienna Austria
8-9 Nov-10	X.Li@iaea.org	Technical Meeting on Good Practices and Case Studies in Financing NPPs	Vienna Austria
15-17 Nov-10	a.stanculescu@iaea.org	3rd RCM on Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the Monju Reactor Vessel	Argonne USA
Nov-10	R.Beatty@iaea.org	16th INPRO Steering Committee Meeting	Vienna Austria
Nov-10	V.Nkong-Njock@iaea.org	Training Course on Nuclear power Infrastructure Programmes and Related Projects in Emerging Nuclear Power States	Obninsk Russian Fed.
17-19 Nov-10	a.stanculescu@iaea.org	3rd RCM on Control Rod Withdrawal and Sodium Natural Circulation Tests Performed During the Phenix End-of-Life Experiements	Argonne USA
17-19 Nov-10	h.subki@iaea.org	TM on the Preparation of a Chapter on Development Status and Prospects for Advanced Computation Methodologies Using Computation Fluid Dynamics for Single- and Two-Phase Coolant Flow	Vienna Austria
7-10 Dec-10	A.Starz@iaea.org	Technical Meeting on Alternative Contracting for and Ownership of NPPs	Vienna Austria
14-17 Dec-10	h.subki@iaea.org	TM on the Publication on Options to Enhance Energy Supply Security with NPPs based on SMRs	Vienna Austria

Impressum

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