



News from the Division of Nuclear Power  
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## Sustainable Nuclear Energy for the 21<sup>st</sup> Century

### INPRO: The First Ten Years



*INPRO 10<sup>th</sup> Anniversary Ceremony, 20 September 2010; from left: J.K. Park, N. Boero, R. Beatty, S. Kirienko, Y. Sokolov, Y. Amano, S. Chu, Y. Sagayama, S. Kondo, F. Mondoloni, S. Banerjee*

The IAEA marked the 10th anniversary of INPRO on the opening day of the 54th IAEA General Conference in September 2010. **IAEA Director General Yukiya Amano** led the celebrations for INPRO, thanking the 31 members participating in the project for their support. Representatives from leading INPRO member states and partners expressed their support for the project.

*Continued on page 2*

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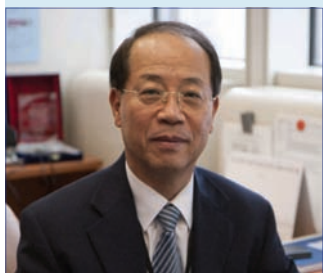
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## Message from the Director



Welcome to the December 2010 Newsletter. Time flies! This is the fifth Newsletter since I joined the IAEA. The 54<sup>th</sup> General Conference was successfully completed with various events including our exhibition of Nuclear Energy, INPRO 10<sup>th</sup> Anniversary, and Briefing on Infrastructure Development for Newcomer Countries. I would like to express my sincere appreciations to all the participants and all NE staff for their hard work in the preparation of those events.

Among other major activities in this quarter are the finalization of the 2012 – 2013 Programme/Budget and an INIR (Integrated Nuclear Infrastructure Review) mission to Thailand in December 2010.

I would like to acknowledge in this newsletter the good work and dedication of Ms. Albane Godard of the Integrated Nuclear Infrastructure Group who has just left us mid November 2010, Ms. Sama Bilbao Leon, the leader of the water cooled reactor technology team in the Nuclear Power Technology Development Section (NPTDS), who is leaving (to teach students at Virginia Commonwealth University in Richmond, Virginia, in the USA) at the end of 2010 after she worked for about 3 years with NENP, and Mr. Atam Rao, the Section Head of NPTDS, who will retire from the IAEA in January 2011, after 5 years of productive service. Mr. Rao has enriched NPTDS activities with his wide experience on technology development of nuclear reactors and other related subjects of great importance to Member States. I have indeed enjoyed working with him and

so thankful to him for supporting me in many aspects. I am going to miss him a lot. I hope he will enjoy his retirement. I would like to express my deep gratitude to all and wish great health and success to each one of them in their future.

Congratulations to Ms. June Mueller-Yu for her receipt of the Distinguished Service Award 2010. I am so happy that she received it and wish her the best in 2011.

This is the time for us to leave 2010 behind and for waiting and planning for the coming 2011. I hope every reader of this newsletter had a fruitful year in 2010 and has wonderful plans for 2011. In January 2011, an INIR mission to the UAE is scheduled and more INIR missions are expected to be requested by Member States. In the first quarter, NENP will have the 3<sup>rd</sup> Divisional retreat.

In this issue of the newsletters, Mr. Oszvald Glockler from Hungary, Ms. Sama Bilbao Leon from Spain, Mr. Sungbong Kim from the Republic of Korea, and Mr. Donald Kovacic from United States of America will introduce their home towns.

I would like also to introduce two new staff members, Mr. Leonhard Meyer from Germany, who recently joined INPRO having long experience on water cooled reactors, and Mr. Katsumi Yamada from Japan who has joined NPTDS on water cooled reactors with extensive experience in the design and development of advanced water cooled reactors.

I wish you all the best and a happy new year!

Jong Kyun Park

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### Sustainable Nuclear Energy for the 21st Century ..... continued from page 1

**Sergey Kirienko**, Director General, of Russia's State Atomic Energy Corporation (Rosatom), delivered a congratulatory message from **Dimitry Medvedev**, President of the Russian Federation, in which he renewed his country's support for INPRO. **Steven Chu**, Secretary of Energy at the US Department of Energy, stressed the importance of INPRO's role in the future of nuclear power. **Norma Boero**, President of the National Atomic Energy Commission of Argentina (CNEA), said that Argentina is fully participating in the INPRO project. **Frederic Mondoloni**, Governor of France to the IAEA Board of Governors, also expressed his country's continuing support to the programme. **Srikumar Banerjee**, Chairman of the Atomic Energy Commission of India

and Secretary of the Department of Atomic Energy, reminded the audience that India has been a member of INPRO since its inception. **Shunsuke Kondo**, Chairman of the Japan Atomic Energy Commission (JAEC), also renewed his country's support for INPRO. **Yutaka Sagayama**, Chairman of the Generation IV International Forum (GIF), spoke of the importance of cooperation between INPRO and GIF for the development of next generation nuclear reactor systems.

During the ceremony, the Director General recognized the contribution of **Yuri Sokolov**, IAEA Deputy Director General for Nuclear Energy and INPRO Project Manager and emphasized that under Mr. Sokolov's leadership and guidance, INPRO has become a well-organized and successful multilateral project.

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## Supporting Nuclear Power Plants

### Evaluation Methodologies in Emerging Nuclear Power States



**REGIONAL WORKSHOP ON PREPARATION OF A NATIONAL NUCLEAR POWER INFRASTRUCTURE EVALUATION. SAROVA WHITESANDS BEACH RESORT & SPA, MOMBASA, KENYA. 23<sup>RD</sup> - 27<sup>TH</sup> AUG 2010.**

With the support of the Kenyan National Council for Sciences and Technology (NCST), the IAEA organized a Regional Training Workshop on Evaluation Methodologies in Emerging Nuclear Power States from 23 to 27 August 2010 at Mombasa, Kenya. The workshop aimed to help national authorities and those responsible for developing and implementing nuclear power programmes in emerging nuclear power states in Africa, establish specific processes, organization and mechanisms for conducting self-evaluations of the nuclear power programme and inform them on the preparation and implementation of the integrated nuclear infrastructure review (INIR) missions.

Excellent arrangements were made and extremely well organized by the NCST, the Kenyan host. The workshop was attended by 34 participants at the decision-making-level from 20 African States. The course revolved around four major inter-related objectives (i) providing knowledge connected to the 19 issues a state has to consider when establishing a nuclear power programme, (ii) sensitizing participants on specific processes, organization and mechanisms for conducting self-evaluations and creating action plans, and providing guidance on conducting a self-evaluation of the nuclear power programme; (iii) informing participants on the preparation and implementation of Integrated Nuclear Infrastructure Review (INIR) missions and other IAEA Review Missions and (iv) further strengthening the networking among emerging nuclear power countries and sharing international experience on the subject matter.

The training workshop achieved its expected outcome. It provided an opportunity to review the status and prospects of nuclear power and to discuss the necessary

actions to carry forward the positive momentum that nuclear power has witnessed in recent years, with special emphasis on organization and evaluation.

The course was also a good forum for exchanging information and sharing experience on good practices and therefore, an excellent mechanism for networking among the participating countries. Some participants informed the IAEA that the previous regional workshop on Milestone Approach enables several African countries to properly advise Decision-Makers on considerations before embarking on nuclear power and increases their ability to conduct the preparations needed to prepare a nuclear power programme. This event was also very useful in advising countries in drafting TC Projects for consideration by the IAEA within the 2012-2013 TC Programme.

As a result of the course and in view of the fact they intend to use that knowledge back home, the participants will be better able to establish the organizations needed to manage evaluation processes for their respective nuclear power programmes.

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### Expanding Nuclear Power Project: A Programme for Success

Expansion of existing nuclear power programmes is a high priority in a large number of countries. Among the 29 countries with operating nuclear power plants, 24 countries plan to expand their program with one or more reactor units. The main growth of world-wide nuclear energy is expected in these countries. A number of IAEA workshops have already been held in China,



Lithuania, Argentina and Brazil, addressing different aspects of expansion of nuclear programme through Technical Cooperation mechanisms.

To prepare the strategic report, a total of nine experts from eight countries participated in the meeting held

from 15 to 17 September. Participants discussed the current issues and listed recommendations to the IAEA direction in support of expanding countries.

Many important issues including project management, establishment of organization, development of human resources, communication with stakeholders, feasibility studies, technical review, financial and policy concerns were discussed and addressed in an integrated manner. New solutions to these issues are needed due to a more competitive environment and meeting more rigorous safety and environmental requirements imposed when expanding nuclear programmes. The strategic report will be published in a 2011 nuclear technology review.

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## Commissioning of Nuclear Power Plants: Guidelines and Experiences

Commissioning, being essential to the subsequent safe operation of the plant, should be carefully planned and executed. The results of commissioning should demonstrate that the requirements and intents of the design, as stated in the system specification and safety analysis report, have been met. Commissioning data will be used for the initial baseline characteristics of systems and equipment, and provide the source values for operational periodic tests as reference data.

The upcoming period of a nuclear renaissance, beginning in a few years, will have access only to limited knowledge and very few experienced commissioning engineers. If several plants are started up simultaneously all over the world, a shortfall of knowledge and experienced personnel will occur. The IAEA has begun preparation of a report which will address all relevant issues related to commissioning, the interface between construction and operation, and to introduce best practices in the commissioning process needed to proceed to a safe and high quality program.

The IAEA has initiated collecting and sharing information among Member States on good practices on commissioning at nuclear power plants and the results are compiled in this report. Seven experts from Argentina, Canada, India, Japan, USA, and Russian Federation joined and prepared the draft version for Guidelines. The report included the following focal points;

- Management of Commissioning
- Commissioning Manpower Control
- Startup test management
- Key Events for commissioning

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## Nuclear Power Plant Instrumentation and Control Technologies

The Technical Meeting on Interfacing NPPs with the Electric Grid: the Need for Reliability amid Complexity was held in August 2010, in Vienna, Austria. The objective of the meeting was to further develop the draft of the Nuclear Energy Series Report with the same title.

The final close-out meeting of the Independent Engineering Review of I&C Systems (IERICS) Mission was held in September 2010 at Doosan in the Republic of Korea. The Mission Report on the prototype of the advanced digital I&C systems designed for APR-1400 NPPs was completed and issued, marking the successful completion of the first IERICS Mission. The second review mission will be held on 6-10 December 2010 in Kirovograd, Ukraine, to review the design of new digital FPGA-based I&C systems installed for the reactor protection, control, and monitoring functions in all Ukrainian NPPs and in the Kozloduy NPP in Bulgaria.

The Technical Meeting on Assessing and Managing Cable Ageing in NPP was held in September 2010, in Halden, Norway. The meeting participants further developed the draft of the Nuclear Energy Series Report with the same title.

Presentations on IAEA's NPP I&C related programs were delivered at the following meetings:

- 3rd Workshop on Applications of Field Programmable Gate Arrays (FPGA) in NPPs was held in Hamilton, Ontario, Canada from 28 September to 1 October 2010. The FPGA technology is an important part of advanced I&C technologies used in both modernizing existing NPPs and in developing new NPP designs.
- 74th Meeting of the International Electrotechnical Commission (IEC), Technical Committee No. 45: Nuclear Instrumentation (TC45) and Subcommittee 45A: Instrumentation and Control of Nuclear Facilities (SC45A) was held in Seattle, WA, USA, on 11-13 October 2010. IEC SC45A is an important organization in the field of NPP I&C, producing widely accepted international standards for the nuclear industry.
- 7th International Topical Meeting on Nuclear Power Instrumentation, Control, and Human Machine Interface Technologies (NPIC & HMIT 2010) was held in Las Vegas, NV, USA, on 8-11 November 2010. This conference is the largest international gathering of experts on NPP I&C and HMIT. The agenda included a total of 45 technical sessions and panel discussions.

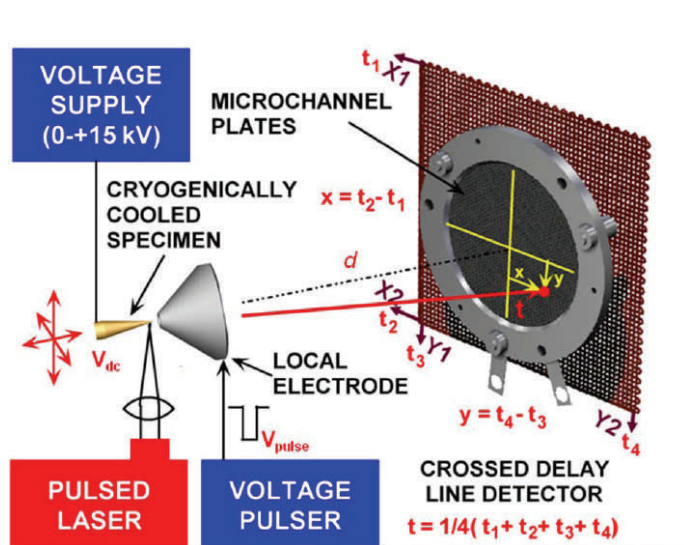
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## Irradiation Embrittlement and Life Management of Reactor Pressure Vessels in Nuclear Power Plants

The purpose of the technical meeting (TM) held from 18–22 October in Znojmo, Czech Republic, was to provide an international forum to review and discuss recent results from research programmes and utility experience on radiation damage and its surveillance, annealing and re-embrittlement of PWR, WWER, BWR reactor pressure vessels (RPVs). Eighty-nine participants from 25 countries and 2 international organizations attended the meeting. The TM was primarily dedicated to irradiation embrittlement and life management of RPVs considered strategic for nuclear power plants life management. Major points were:

- Application of measured mechanical property changes,
- RPV integrity requirements and assessment methods,
- Embrittlement management methods,
- Characteristics of neutron irradiation embrittlement of RPV materials for long term operation.



Atom Probe Tomography is performed by evaporating atoms from tip of a needle and subsequent analysis of composition and position

In connection with the technical meeting, a tutorial session was organized on 18 October 2010 by the Joint Research Centre of the European Commission. The session was recorded in its entirety for the purpose of the Joint IAEA/EC-JRC Project on Development of a Multimedia Course on WWER RPV Embrittlement).

General conclusions and important opportunities for the future are:

- To utilize manufacturing techniques that minimize micro structural variability, both for structural welds and cladding.
- Improved knowledge about the irradiation toughness and irradiation assisted stress corrosion of stainless

and is basic for production of future reactor internals.

- Advanced surveillance programmes should be developed for new reactors, based on lessons learned from current surveillance programmes.
- It is important to harmonize the evaluation and assessment codes for the RPV integrity assessment including neutron dosimetry, fracture toughness evaluation and components behavior, based on current scientific and technical knowledge and eliminating unnecessary conservatism.
- Significant advances in micro structural examination techniques will allow greater understanding of mechanisms, and better input to modeling efforts.
- Analysis of large databases, including accelerated irradiation, will allow better understanding of radiation damage mechanisms, and dependencies on the variables involved. It will enable more accurate predictions of damage for structural integrity assessments, e.g. through-RPV wall attenuation.
- Several new embrittlement models are now available, it may be possible to produce a general model using the best features of these.
- Non-destructive techniques will mitigate the lack of surveillance material for LTO of RPVs.

The meeting was organized by the IAEA in cooperation with EC-JRC Institute for Energy and all the presentation materials are available at the IAEA website.

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## Maintaining and Operating the Power Reactor Information System (PRIS) Database and its Products

PRIS is a reference database on nuclear power plants and consists of nuclear power plant basic information, design characteristics, decommissioning data, energy production and unavailability, outages and performance indicators. The PRIS technical meetings are held biannually, with the latest meeting held in Vienna from 4-7 October. The objective of the Technical Meeting was to provide information about the current status of the system, its latest development and to get feedback from the PRIS users and data providers. Through discussions among participants and topical work-group sessions, the recommendations concerning PRIS activities and future development have been formulated.

The meeting was attended by 31 experts from 3 international organizations (EC, WANO and WNA) and 22 Member States. The participants were designated national correspondents and PRIS users from nuclear power plant operating utilities, regulatory bodies and other organizations. The meeting participants recognized the services provided by PRIS to the nuclear industry. They appreciated the efforts of the IAEA in maintaining and operating PRIS with quality data and

developing a new PRIS reporting system (PRIS- Statistics).



The participants agreed that PRIS will continue with only the one on-line application for statistical report generation. Considering the status of development of PRIS-Statistics, it was recommended to stop using the former applications PRIS-PC and PRIS-CD. The participants support further enhancement and optimization of PRIS-related applications and outputs, especially in view of current and future development / requirements of the nuclear industry.

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## Human Resources Development and Personnel Training

### E-learning system for countries embarking on nuclear power

An e-learning system on Basics of NPP Policies, Management and Technology for Belarus nuclear power programme is being developed under the IAEA Technical Cooperation Project BYE/0/006 on Developing Human Resources and a Training System for Belarus Nuclear Power Programme and will be deployed this year. It is a web-based system containing 10 training modules, about 200 training objectives and 900 test questions, addressing the following



content: Basics of Nuclear Infrastructure, NPP Safety Concepts, NPP Technology, Integrated Management System, NPP Policies, Emergency Preparedness, Fire Protection, Industrial Safety, Radiation Protection and Radiological Control, and Waste Handling and House-keeping. The target audience for this e-learning system is senior, middle and first level managers of the Ministry of Energy, managers of all other organizations participating in national nuclear power programmes, personnel of the Regulatory Authority, university lecturers and students.

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## Developing the Partnership of Nuclear Industry and Education

An IAEA technical meeting on Training and Educational Systems for Nuclear Industry was held from 28 September to 1 October 2010 at the Uppsala University in Sweden. Forty-six participants from 22 countries and the IAEA represented universities, academia, nuclear facilities, ministries, regulatory bodies, R&D organizations, training organizations, NPP vendors, and suppliers of training tools. One of the major achievements of the meeting was an exchange of experience on how to better communicate the industry needs to the educational system and what support is needed from industry and governments to ensure a reliable supply of competent workforce for nuclear power programmes. World-wide good practices in nuclear education and training were discussed. Countries operating NPPs and those who are embarking on nuclear power both took part.

Another example is the successfully completed project for Ukraine which is operating NPPs, implementing a long term operation programme and expanding its nu-

clear power programme by building new units. This project demonstrates a wide range of IAEA assistance:

- Improving the process of identifying training



needs and evaluating training;

- Development of a national concept on personnel training;
- SAT-based training procedures and training material;
- Training of managers, instructors, and operations and maintenance staff;
- Improvement of on the job training;
- Development and supply of training tools (multimedia e-learning systems, mock-ups, physical models);
- Upgrade of maintenance training system at the Zaporozhzhie NPP (the largest NPP in Europe);
- Implementation of a pilot project on knowledge management at the Zaporozhzhie NPP;
- Involvement of Ukrainian managers and specialists in the networks on human resource development and training.

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## INPRO

### Technical Session: The Future of Nuclear Innovation

About 100 delegates and IAEA staff attended the INPRO Technical Session held on the occasion of INPRO's 10<sup>th</sup> anniversary on 22 September at the IAEA Library. The session included invited talks by Canada, Germany, Japan, Kazakhstan and the Generation IV International Forum (GIF) on the future of nuclear innovations and a panel discussion with participants from France, India, Indonesia, the Russian Federation and the USA who shared views and visions about the future role of INPRO.

**R. Duffey**, Principal Scientist of Atomic Energy of Canada Ltd (AECL) spoke about innovative eco-nuclear reactors that would contribute to sustainable global energy supply; **J. Knebel**, Head of the nuclear programme of the Karlsruhe Institute for Technology (KIT) in Germany, discussed transmutation issues of Generation IV reactors; a forum to stimulate knowledge innovation for nuclear energy and related activities was proposed by **S. Kondo**, Chairman of the Japan Atomic Energy Commission, while **T. Zhantikin**, Chairman of the Atomic Energy Committee of Kazakhstan, talked about the challenge to develop a nuclear power programme for a country with a small/medium-sized grid and ample natural resources; finally, **H. McFarlane**, Technical Director of GIF, focused on innovation to deliver commercially viable nuclear energy (GIF).

A panel chaired by **A. Burkhart** from the US Department of State discussed options and proposals for INPRO's future activities that were then further elabo-

rated during the 16<sup>th</sup> meeting of the INPRO Steering Committee in November 2010. Panelists included **J. Bouchard**, Commissariat à l'Énergie Atomique (CEA), France, **R.K. Sinha**, Bhabha Atomic Research Centre (BARC), India, **H. Hastowo**, Indonesian Atomic Energy Agency (BATAN) and **A. Bychkov**, Research Institute of Atomic Reactors in the Russian Federation.



*From left: R. Grossi, Chef de Cabinet, R. Beatty, INPRO, DG Amano, DDG-NE Sokolov*

In addition, the IAEA received 27 congratulatory letters from INPRO members and cooperating organizations. A book containing all letters was presented to Director General Amano on 5 October 2010.

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### INPRO Dialogue Forum: Institutional Challenges of Multilateral Approaches to Sustainable Nuclear Energy Deployment

Recent INPRO studies are increasingly showing the importance of implementing multilateral approaches to ensure sustainable and optimal deployment of nuclear energy to the end of the century. Multilateral approaches have been considered in the past to address certain challenges associated with nuclear energy deployment. Traditionally, the focus of multilateral cooperation has been the nuclear fuel cycle. For the first time, a workshop, held within the INPRO Dialogue Forum on Nuclear Energy Innovations in October 2010, also explored other key areas where multilateral cooperation is crucial if nuclear energy is going to live up to its full potential.

INPRO Project Manager and Deputy Director General for Nuclear Energy Yuri Sokolov stressed in his opening speech that, "for nuclear power to be sustainable and contribute to the world's energy supply mix in the long term, it must have convincing responses to the challenges of further development. Among these challenges are the availability of uranium resources, management of waste, safety, complex infrastructure development,

non-proliferation and a need of new technologies and innovations. Institutional innovations will be needed to assist the implementation of technological innovations. This includes regional approaches and cooperation in creating centers for technical support, enrichment and fuel fabrication, joint infrastructure building and use, management of spent fuel and high level waste, cooperation on closing the fuel cycle, and new approaches for construction and operation of nuclear power plants. All these are essential elements that can contribute to the sustainability of the nuclear power”.

Five areas were addressed at the workshop:

- Multilateral Approaches in Nuclear Fuel Cycle (front and back-end)
- Multilateral Approaches in Infrastructure for New Nuclear Power Programs
- Multilateral Approaches in Safety, Licensing and Regulation
- Financing Issues in Multilateral Approaches to Nuclear Energy Development
- Multilateral Approaches in Prototypes and Demonstration of Innovative Technologies.

For each of these areas, participating experts provided examples from past and current initiatives and experiences that lay the ground for discussions on the main institutional challenges that face multilateral approaches. These challenges identified a broad range of topics that need further discussion such as public awareness and support, harmonization of approaches and practices, long-term commitments between partners, and other areas that are specific to each topic. The presentations and discussions will be analyzed and summarized in a meeting report that will be used as input for future INPRO activities.

The workshop on *Multilateral Approaches to Sustainable Nuclear Energy Deployment - Institutional Challenges* was conducted in cooperation between INPRO,



INPRO Dialogue Forum Workshop,  
4-7 October 2010, IAEA, Vienna

the Planning and Economic Studies Section (PESS), the Office of External Relations and Policy Coordination (EXPO), the Safety Assessment Section of the Division of Nuclear Installation Safety (NSNI), the Safety and Security Coordination Section (SSCS) of the Department of Nuclear Safety and Security, the Integrated Nuclear Infrastructure Group (INIG), and the Division of Nuclear Fuel Cycles and Waste Technology (NEFW).

It was sponsored by the Department of Technical Cooperation (TC) through TC project INT/41/142: *Promoting Technology Development and Application of Future Nuclear Energy Systems in Developing Countries*. Presentations are available at <http://www.iaea.org/INPRO/2010-Oct-DF2.html>.

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## Poland to become 32nd Member of INPRO

Ms Hanna Trojanowska, Government Commissioner for Nuclear Power and Undersecretary of State, Ministry of Economy, has conveyed to the IAEA the request of the Government of Poland to become a full member of INPRO. This also includes an offer of making extra-budgetary contributions to the Project.

Described often as the non-nuclear island in Central Europe, Poland decided in 2009 to introduce a nuclear power programme which will be designed and implemented following a public debate and the Government's final approval. Poland has made a significant commitment to a nuclear power programme in its recent mid-term energy policy strategy until 2030, which includes “a diversification of power generation sources through implementation of nuclear power”. As a newcomer country, Poland will benefit from support to national long-range strategic nuclear energy planning and decision making, an area where INPRO has a long-term expertise.

Mr. Y. Sokolov, INPRO Project Manager and IAEA Deputy Director General of Nuclear Energy, welcomed Poland's intent to become a new INPRO member and emphasized the country's opportunity to benefit largely from the international cooperation facilitated by INPRO, mostly in terms of provision of tools, models, publications and expertise in the support of sustainable energy deployment and technical innovation. Furthermore, as a full member, Poland will be able to actively participate in the dialogue between technology holders and users as well as take advantage of the results and findings of INPRO studies.

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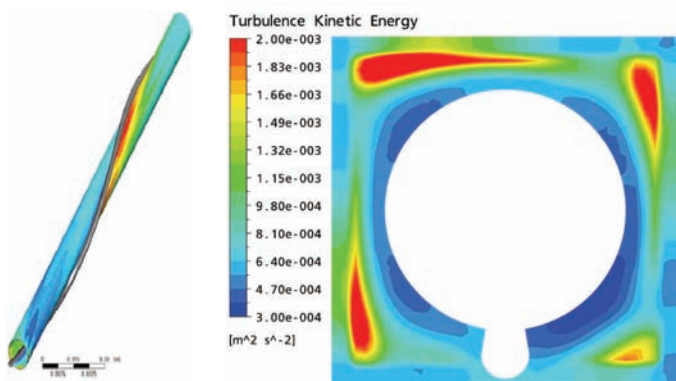


## Technology Development of Nuclear Power Reactors

### Application of CFD Codes for the Design of Advanced Water Cooled Reactors

Computational Fluid Dynamics (CFD) codes are very powerful multipurpose tools based on finite element methods that could be used to perform numerical simulations of many physical phenomena. Together with wind tunnel experimentation, CFD codes have played a key role in aerodynamic design for many years, largely reducing the need for prototypes or additional expensive testing. In the nuclear industry, experts envision the future application of CFD codes, once they are properly verified and validated, as a substitute for expensive experimental testing as they are able to provide valuable qualitative and quantitative information of many key physical phenomena. However, since current CFD codes have not yet reached the desired level of maturity to allow such use for nuclear plant design, additional work is needed.

The development and testing of CFD codes requires intensive work on complex physical modeling and numerical schemes. In parallel, in order to benchmark the performance of the CFD codes, experimental databases are needed, both for separate effect tests and for full size systems tests. The verification and validation of CFD codes, thus the evaluation of their modeling and simulation capabilities, are some of the critical issues associated with their use for the design of advanced water cooled reactors. In addition, a high degree of user expertise is necessary to appropriately select CFD code parameters and options, such as the turbulence modeling, the boundary conditions, the meshing, the numerical scheme options, etc, and also to draw clear conclusions from the results provided by the codes.



*Turbulent kinetic energy and temperature distribution in the surface of a fuel rod with a wire wrapped spacer for the HPLWR project (Credit: Zu and Laurien, University of Stuttgart, 2009)*

Recognizing the importance of fostering international collaboration in the development, verification and validation of CFD codes for the modeling and design of

advanced water cooled reactors both NE's Technical Working Groups on Advanced Technologies for LWR and HWR (TWG-LWR and TWG-HWR) recommended the IAEA to pursue this topic. The IAEA activities in support of CFD codes development aim to help coordinate the work and the resources devoted to this effort by the various institutes around the world and to facilitate the communications and the exchange of information among them.

Two parallel activities are being pursued to achieve these objectives; First, the compilation of a document on the state of the art in the use of CFD codes for modeling, simulation and design of advanced water cooled reactors, including best practices for the verification and validation of CFD codes. The focus of the proposed document is modeling for technology development and design, in contrast with existing reports that concentrate in the use of CFD codes for nuclear safety applications. However, common issues and interests between both efforts will certainly be explored. The identification of gaps of knowledge and areas with large potential for joint collaboration is also one of the goals of this report. Second is a collaborative research project (CRP) that will be initiated in 2012. This CRP will foster international collaboration towards filling the knowledge gaps and areas for improvement identified in the above document, and may also coordinate international benchmarking exercises towards the validation and verification of CFD codes for water cooled reactor design.

A technical meeting on the Application of CFD Codes for the Design of Advanced Water Cooled Reactors, was held at the IAEA HQ in Vienna, Austria in December 2010 to kick-off these new IAEA activities. This meeting sought to gather world experts in the use of CFD codes for nuclear reactor design to initiate the compilation of the above document and to better define the terms of reference for the new IAEA CRP on CFD codes. More information about the meeting can be found in the IAEA website

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### Cooperation between IAEA and COG

Two CANDU Owners Group Inc. (COG) representatives and a senior manager of AECL Chalk River Laboratories visited IAEA on 12 October 2010. The objective of their visit was to share their experience and to discuss the potential cooperation between the two organizations. IAEA staff from the Division of Nuclear Power, the Division of Nuclear Fuel Cycle and Waste Technology, and the Division of Nuclear Installation Safety participated in the meeting.

The COG is a not-for-profit organization dedicated to providing programs for cooperation, mutual assistance and exchange of information for the successful support,

development, operation, maintenance and economics of CANDU technology. All Heavy Water Reactor (HWR) Operators in the world are members of COG, but COG R&D programs are mainly supported by AECL and Canadian Utilities. Its representatives presented the role of the COG as well as the activities being carried out under the COG R&D programs. COG R&D has focus on members' strategic drivers (maintain a high level of operational safety, improve plant reliability, meet regulatory obligations, etc) and process improvements. One of the big initiatives in the COG is the development of a next generation toolset for the conduct of safety and operational support analyses.

IAEA staff also presented the HWR related activities under the IAEA programs. Currently most HWR related activities to support IAEA Member States are systematically planned and reviewed through the Technical Working Group on Advanced Technologies for Heavy Water Reactors (TWG-HWR). New activities suggested for 2012-13 IAEA Program & Budget by TWG-HWR were discussed in the meeting for potential cooperation to maximize the synergy effect. The COG is invited to attend the TWG-HWR meeting as an observer. The following areas were defined for potential cooperation:

- Identification and collection of the needs of HWR countries for the development of a next generation toolset
- Improvement of IAEA HWR simulators for education purposes
- IAEA Interregional Technical Cooperation Project to improve the performance, safety, and fuel cycle options of HWRs,
- International Workshop on good practices in HWR operation
- CRP on axial and radial creep of HWR pressure tubes
- International conference on the future of HWRs

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## Fast Reactors and Accelerator Driven Systems

IAEA's activities in the field of advanced fast neutron systems research and technology development are implemented within the framework of the Technical Working Group on Fast Reactors (TWG-FR).

An important focus of the Project over the third quarter of 2010 consisted in finalizing its activities for IAEA's Programme and Budget (P&B) Cycle 2012 – 2013. In the P&B 2012 – 2013, based on the advice as well as on the needs expressed by the TWG-FR Member States,

and thanks to the leverage offered by the R&D&D programs being implemented in the TWG-FR Member States, the Project will:

- Sustain 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
- Organize regular topical technical meetings to exchange information
- Establish a forum for broad exchanges on technical requirements for 4th generation fast reactor systems
- Carry out IAEA Coordinated Research Projects (CRPs) of common interest to the TWG-FR Member States
- Provide technical expertise/support to NS with the development of fast reactor safety standards
- Secure training and education in the field of fast neutron system physics, technology and applications.

The definition of the P&B 2012 – 2013 activities of the Project was based on the identification of the areas in which the Project can make an impact, have a positive outcome for, and provide added value to Member States activities, *viz.*

- Modeling and simulation of various phenomena (neutronics, thermal hydraulics, thermal mechanics) relevant to fast reactor R&D and core design. Specifically, the activities that the Project shall pursue in order to contribute towards meeting the needs of the Member States in this area are data and computer code verification, validation, and qualification (V&V&Q) with the help of theoretical and experimental benchmark exercises, including severe accident analyses.
- Support for the planning, development and realization of fast neutron spectrum experimental (irradiation) facilities, as well as the planning and implementation of experimental programmes at such facilities. Specifically, the Project shall foster and facilitate international collaboration around three fast reactor facilities that will play a significant research and technology development role over the next 10 – 15 years, i.e. Monju in Japan (restarted on 6 May 2010), MYRRHA in Belgium (government approval for design funding received in March 2010), and MBIR in Russian Federation (planned BOR-60 replacement).

The following 2010 third quarter Project activities are also worthwhile mentioning: Firstly, the participation [with an invited paper, the participation in a round table discussion, and two lectures delivered to IGCAR (Indira Gandhi Centre for Atomic Research) and BHAVINI (Bharatiya Nabhikiya Vidyut Nigam Limited) staff] in the Second International Conference on Asian Nuclear Prospects (ANUP 2010, Mamallapuram/Chennai, India,





*Lecture by the TWG-FR Scientific Secretary to IGCAR and BHAVINI staff, India, October 2010 (photo courtesy of IGCAR)*

in October 2010); and, secondly, the submission to the IAEA internal publication committees of two technical publications, viz. on Improving Economics of Fast Reactor Designs by Reducing the Amount of Plant Materials and on Status of Fast Reactor Research and Technology Development.

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## Gas Cooled Reactors

Seven experts from five Member States attended a meeting which took place in November 2010 in Vienna. The meeting was aimed at initiating information exchange and sharing of experiences in the licensing process of HTGR projects, with a view of (1) assimilating the remaining licensing experience from past HTGR projects, (2) understanding the challenges faced by current designers of HTGRs in the licensing projects; and (3) facilitating a dialogue between the designers and regulators to better understand each other's needs, requirements and capabilities. Since not many reactors of this type have been built and operated, the licensing process for these reactors is a challenge for both the designers and the regulatory bodies because current licensing guidelines originally meant for water-cooled reactors do not readily apply to the HTGRs. Past HTGR programmes which have gone through the licensing process have valuable lessons-learned to share with current designers and future ones. A forum for both the designers and regulators becomes necessary to provide for a platform where the needs and requirements of either side can clearly be understood and this is what this meeting tried to achieve.

The meeting identified several technical issues that made the licensing process for HTGRs challenging such as: the expansion or development of existing codes and standards to accommodate high temperature materials; to address safety issues associated with co-location (external hazard, radiological hazard to the product specifically tritium, process feedback / interaction); fuel performance and qualification issue including

manufacturing, irradiation tests, use of historical data being equivalent, quality control (parameters to control, commercial scale quality); mechanistic source term, graphite oxidation (resulting from air and water ingress) and a few more others.

Procedural and/or organizational issues were also highlighted, namely: human resource development at the regulator; lack of exchange of information between regulators and vendor interaction on licensing approaches and safety approach.

Member States present resolved to work together and through the IAEA to share experiences and to exchange ideas and information as the regulation covering these reactor type develops. A Technical Meeting on a related subject of core-wide fission product release source terms and isotope migrations in HTGRs is scheduled to be held in Vienna from 26 - 28 April 2011.

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## Small and Medium-Sized Reactors

Since early 1980s, the IAEA has had an established programme on Small and Medium-sized Reactors (SMR) managed by the Nuclear Power Technology Development Section at the Division of Nuclear Power under the Department of Nuclear Energy. In the past few years, international nuclear community has seen great potential of SMRs for the imminent future and anticipate challenges to be resolved prior to their deployment.

The IAEA plays a leadership role to coordinate efforts of Member States to facilitate the development of SMRs by taking systematic approach to identify key enabling technologies to achieve competitiveness and reliable performance of SMRs, also by addressing common issues to facilitate deployment. The efforts are made to ensure overall coordination of Member States experts by facilitating the sharing of information and transfer of knowledge among stake holders, also to help establish international network and task forces on SMRs activities.

The IAEA's ultimate goal on SMR is to develop international recommendations and guidance on SMRs focusing to address specific needs of developing countries with small grids, so those countries can possess an inherent capability on technology evaluation and address licensing issues. In this regard, the IAEA is preparing two workshops in 2011 that may be of interest and benefit for Member States also stake holders of SMRs. The Workshop on Advanced Nuclear Reactor Technology for Near Term Development will be held on 4 – 8 July, 2011 at the Vienna International Centre (VIC). The workshop will cover all nuclear reactor technologies, including that of SMRs. The other workshop is on Technology Assessment of SMR Deployable by 2020 scheduled to be held on 5 – 9 December 2011.

On the R&D for SMRs, since 2008 the IAEA has an on going coordinated research project (CRP) on Development of Advanced Methodologies for the Assessment of Passive Safety System Performance in Advanced Reactors. The 3<sup>rd</sup> research coordination meeting (RCM) will be held on 4 – 7 April 2011 to be attended by 7 Member States as participants and 2 countries as observer. For the purpose of the CRP, a thermal-hydraulic test to obtain new test data on natural circulation for benchmarking has been conducted and arranged by the University of Pisa in Italy. The IAEA is in the final stage to publish two publications on Options to Incorporate Proliferation Resistance Features to NPPs with SMRs and on Approaches to Assess Economic Competitiveness of SMRs. Since SMRs also could be applied in non-electric applications (i.e. desalination plants and heavy oil recovery), the applications for which large reactors generally are not feasible, an activity on the latter subject will also be prepared by the IAEA.

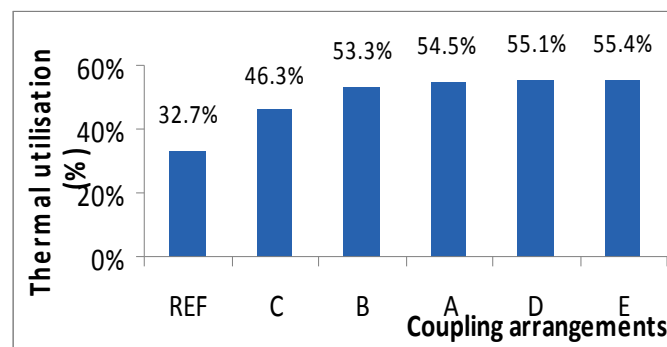
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## Non-Electric Applications of Nuclear Power

Based on valuable feedbacks from many international experts, DEEP is currently being updated. The new version of DEEP will include modern programming concepts and some new features which will be of interest to both newcomers and experts and will facilitate the understanding of the desalination process, variables interactions and co-generation benefits.

Some of the DEEP new features have been demonstrated during the 2nd RCM of the CRP on New Technologies for Sea-water Desalination Using Nuclear Energy that took place in October 2010.

Another important activity, which will support the analysis of cogeneration aspects of nuclear desalination systems in particular, is being conducted. The aim of this activity is to investigate optimal schemes of coupling nuclear desalination systems and thus improve the



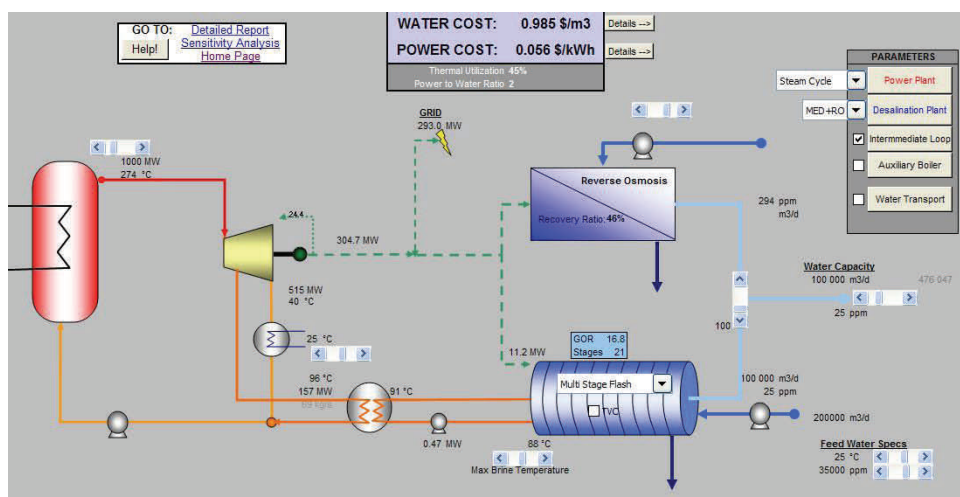
Potential of cogeneration for primary energy savings.

thermal utilization of power plants allowing primary energy savings. The expected research output of this activity will allow the establishment of a set of “rule of thumbs” for an economically and energetic optimal selection of the coupling scheme, given power and desalination plant main features. Thus, this technical approach will help to improve economic evaluation of cogeneration systems, particularly water desalination, and their attractiveness for both nuclear and conventional power plants.

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## Completing a Fellowship on Non-electric Applications, by Dedy Priambodo, Indonesia

I am happy that I am returning to my country after completed my fellowships on the Field of Nuclear Power for



Graphical user interface of new DEEP version

Desalination and other Non-electric Applications, but I am also sad to leaving kind people and friends. This programme very important to improve my technical competence especially in Nuclear Desalination Technology, to support Indonesian Nuclear

Programme in Bangka Belitung Island. *I would like to express my deeply grateful appreciation to Mr. Ibrahim Khamis, my supervisor and his team Konstantinos C. Kavvadias & Ignacio Garcia Sanchez-Cervera , for his patience and guidance throughout my fellowships from October until 1<sup>st</sup> December.*



## CONGRATULATION



to  
**Ms. June Mueller-Yu for her receipt of  
 the IAEA Distinguished Service Award  
 2010**

## My Hometown

In this edition of My Hometown, NENP introduces:

**Notsu Reyet, By Oszvald Glöckler**

For a while, I felt Vienna was my new surrogate hometown. The Greater Toronto Area (GTA) could have been a fun place too, but that romantic notion of the Great Canadian Wilderness was taken away by the madness of express highways and suburbia's manicured lawns saturated with pesticides, not to mention that the GTA is a flat land, missing the third and all the higher dimensions.



Wherever I stayed in the past, usually I felt like I was home. But never for too long. After all, to what end are we in this World? To keep searching for a place in it, so that we eventually feel like we are home. But then the "rotation policy" kicks in, and you move on again.

Instead of trying to choose a "hometown" from the various places I have lived in the past 35 grownup years, in Hungary, USA and Canada, I will tell you a few words about my home village, called Magyaregregy (don't even try to pronounce it), and its region of gentle rolling hills and mountain slopes in Southern Hungary. This village, with fewer than 900 inhabitants and beautiful traditional farm houses, hides in a valley in the Mecsek mountain region. It was first mentioned in a document

in 1554, when it was named Egregy, which refers to alder trees. Just outside the village, the Máré castle was built in the 13th century in the Gothic style, on the site of a Roman watchtower. The one-time knight's castle was later rebuilt in Renaissance style.

Not so far from Magyaregregy is the town of Komló, where I later lived and went to school. In the 1950s the town became the center of a black coal mining area, growing from a small village to a "socialist city", the product of the industrial policy of the socialist era. In the 1990s, the industrial policy of a different kind of era closed the coal-mines, throwing the town into a massive recession and a great proportion of the population into unemployment. Even though I left my town 35 years ago, I remain attached to it and to its people, which the town rewarded three years ago by granting me "honorary citizen" status.

Close to Komló lies the regional capital of the South-



*Széchenyi Square in Pécs with the Mosque of Pasha Qasim*

Western part of Hungary, the city of Pécs (also called *Fünfkirchen* in German, or *Sopianæ* in Roman). Its latest fame has come from the cultural world. This year Pécs is the European Capital of Culture (sharing this title with Istanbul and Essen). An incredible cultural program of concerts, exhibitions, museums, festivals, and performances has been put together for this occasion. The eventful programs are hosted by the medieval sites, both of different religions and historic buildings, ranging from Roman burial chambers to the porcelain factory of Zsolnay. The surrounding region with a sub-Mediterranean climate will please the outdoorsy types as well with hiking routes, dripstone caves, lakes, thermal spas, and wine regions. In any case, the natural and cultural attractions of the region could fill your long weekend here, only a 5-hour drive away from Vienna.

*Oszvald Glöckler is a nuclear power engineer in the Nuclear Power Engineering Section*

## Bilbao, Spain, *By Sama Bilbao*

I am doubly lucky: not only is my last name "Bilbao" but I also was born there. In Bilbao-Bilbao even. Bilbao is the capital of Bizkaia, one of the three provinces of the Basque Country, in the north coast of Spain. Perched between the green Basque Mountains and the Bay of Biscay, Bilbao straddles both sides of the estuary of the Nervion River.



Since its foundation in the early fourteenth century, Bilbao has been a commercial hub that enjoyed significant importance in the North of Spain, mainly thanks to its port activity based on the export of iron extracted from the Biscayan quarries. Throughout the nineteenth century and beginnings of the twentieth, Bilbao experimented with heavy industrialization that made it the centre of the second industrialized region of Spain... and also a not particularly beautiful place. Over the last 25 years, however, the city has been completely transformed from a grey and environmentally run-down city with its industrial production system in crisis to one of the most attractive cities in Europe.

The famous Bilbao Guggenheim Museum by architect Frank Gehry has become a symbol of the new Bilbao and its transformation. Complementing these, we can



*The Bilbao Guggenheim Museum*

also find other features of the historical Bilbao like the Theater Arriaga and the characteristic Puente Colgante (The Hanging Bridge) and the beautiful Casco Viejo (old town). In 2010 the city of Bilbao was awarded the Lee Kuan Yew World City Prize, which is considered equivalent to the Nobel prize for cities and recognizes the efforts towards the creation of vibrant, livable and sustainable urban communities around the world.

I am, of course, completely unbiased but I really love Bilbao: The green of the mountains, the blue of the ocean, the Ría zigzagging through the city, the bridges, the parks, the graceful combination of old and modern buildings, the food and most importantly... the people. Bilbainos are very hard working people, but warm, friendly and fun. The txikiteo (Basque for tapas crawl) is extremely popular in Bilbao, with hundreds of people on the streets of the old town wandering from bar to bar, each known for its specialty pintxos (Basque for tapas). The txikiteo has a strong socializing component, and it is usually regarded as a cornerstone of Basque Culture and Society.



*The Puente Colgante (Hanging Bridge)*



*Pintxos*

I encourage you to visit Bilbao and experience its beauty and energy for yourself. You will love it too!

**Sama Bilbao y Leon** is Technical Head of Water Reactors Technology Development in the Nuclear Power Technology Development Section.

## Busan, Republic of Korea

*By Sungbong Kim*

Busan is a large harbour city with 4 million inhabitants located in the southern region of the Korean peninsula. It also serves as the country's main port for international cargo, as well as passenger ferries to Japan and Jeju Island. This beautiful city has splendid coastal scenery and is famous for its seafood and beaches, as well as the Hallyosudo Waterway with its picturesque islands.

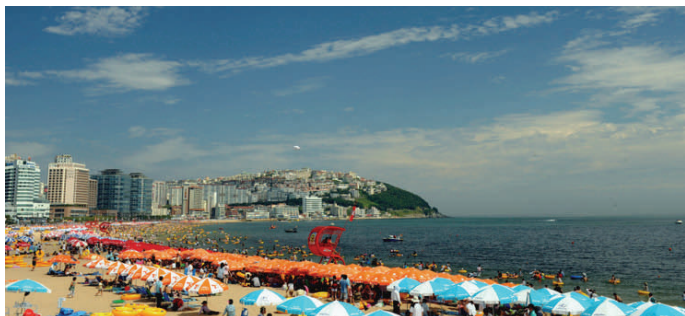


The Busan fish market has a huge selection of fresh seafood. Although primarily known as a port, the city has many steep hills, creating a very unusual mix of mountains and ocean. For centuries, life in Busan was simple, and the main means of making a living were fishing, shipping, and tourism. However, since industrialization started, the way of life in Busan has been changed. To bring hopes and dreams to the city's



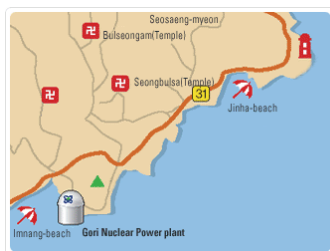
growing population, clean and efficient nuclear energy had to be utilized, and Busan became the foundation for national economic growth through energy supply and heavy industry.

The Gori region, a suburb of the city of Busan, became the birthplace of the first national nuclear power plant because of its optimal geological conditions (hard-ground, abundant water), infrastructure (industry and academia), and people's attitude toward nuclear energy.



*Haewoon Beach, Busan*

The people of Busan are very frank and straightforward as is usual for a typical harbor city, and this matches well the safety culture necessary for operating a nuclear power plant. The first nuclear power plant was constructed in 1978; today, four units having 3137 MW(e) are in operation, and another four units having 4800 MW(e), 2×1000 MW(e), 2×1400 MW(e) are under con-



*Location and view of the Gori NPP, Units 1-4*

struction. Many visitors from all over the world visit Busan every year not only to enjoy the city itself but also to visit the nuclear complex.

*Sungbong Kim is a Cost-Free Expert working in the INPRO Group.*

## **Knoxville, Tennessee, USA**

*By Donald Kovacic*

My adoptive hometown is Knoxville, Tennessee in the south eastern United States of America. I was born in the north eastern part of the USA, but I have worked many years in the south east and have adopted it as my home. Founded in 1786, Knoxville is the third-largest city in the state of Tennessee, behind Memphis and Nashville. In July



2007, the estimated population was 183,546, with a total of 655,400 living in the surrounding area.

After Tennessee's admission into the Union in 1796, Knoxville was the state's first capital until 1819. The city was named in honor of the first Secretary of War, Henry Knox. One of Knoxville's nicknames was the "Marble City" because in the early 1900's Knoxville supplied Tennessee pink marble to much of the country. Notable buildings such as the National Gallery of Art in Washington are constructed of Tennessee marble.

I first came to Knoxville after graduating from the University of Cincinnati in Ohio in 1986 to work for the Tennessee Valley Authority's (TVA) nuclear power program. Being part of the south, Knoxville is also known for its southern hospitality. Coming from a big city in the industrialized north, it took me a long time to get used to greeting people on the street with a friendly "howdy." When driving, people often give you a friendly wave and even farmers plowing their fields will stop to wave!

A great feature of Knoxville is that it is very close to the Great Smoky Mountains. The Great Smoky Mountains National Park was established in 1934 and it is the most-visited national park in the USA, with over 9 million visits per year. The hardwood forests in the range's lower elevations are among the most diverse ecosystems in North America. During the year my family and I visit the Smoky Mountains many times for hiking, swimming, and for picnics. The name Smoky comes from the natural fog that often hangs over the range, which looks like large smoke plumes from a distance. This fog, which is most common in the morning and after rainfall, is the result of warm humid air coming from the Gulf of Mexico, which then cools rapidly in the higher elevations of the Smoky Mountains.



*Knoxville, Tennessee 1982 World's Fair site*

I really enjoy my adopted home of Knoxville as it offers both natural beauty and access to a modern city and state-of-the-art technological research and development facilities. There is a very good reason why the region's population is growing as people come to visit for work or visiting friends and then decide to stay...as I did!

*Donald Kovacic is a Cost-Free Expert working in the Nuclear Power Engineering Section and supporting the development of nuclear infrastructure.*

## Upcoming Events

Date	Contact	Title	Venue	Country
31 Jan– 1 Feb 11	<a href="mailto:B.M.Tyobeka@iaea.org">B.M.Tyobeka@iaea.org</a>	Technical Meeting of the Steering Committee of the Graphite Knowledge Base	Vienna	Austria
2-4 Feb 11	<a href="mailto:B.M.Tyobeka@iaea.org">B.M.Tyobeka@iaea.org</a>	2nd RCM for Graphite Irradiation Creep CRP	Vienna	Austria
8-11 Feb 11	<a href="mailto:M.Aoki@iaea.org">M.Aoki@iaea.org</a>	Technical meeting/workshop on the Introduction of Nuclear Power Programmes– Management and Evaluation of a National Nuclear Infrastructure	Vienna	Austria
7-10 Feb 11	<a href="mailto:K.S.Kang@iaea.org">K.S.Kang@iaea.org</a>	Technical Working Group on Life management of Npps	Vienna	Austria
9-10 February	<a href="mailto:K.S.Kang@iaea.org">K.S.Kang@iaea.org</a>	Preparation meeting for 2012 PLiM conference	Vienna	Austria
7- 11 March	<a href="mailto:K.S.Kang@iaea.org">K.S.Kang@iaea.org</a>	Hands-on Experience in Developing and Managing Nuclear Power Programme	Seoul	Republic of Korea
21-26 Feb 11	<a href="mailto:A.stanculescue@iaea.org">A.stanculescue@iaea.org</a>	Workshop/Seminar on Sodium Cooled Fast Reactor Science and Technology	Bariloche	Argentina
7-9 March 11	<a href="mailto:A.stanculescue@iaea.org">A.stanculescue@iaea.org</a>	TM on Fast Reactor Deployment Issues	Vienna	Austria
21-23 March 11	<a href="mailto:J.H.Choi@iaea.org">J.H.Choi@iaea.org</a>	The 2 <sup>nd</sup> Workshop for ICSP on Integral PWR Designs	Vienna	Austria
28 March – 1 Apr 11	<a href="mailto:B.M.Tyobeka@iaea.org">B.M.Tyobeka@iaea.org</a>	Regular meeting of the Technical Working Group on Gas-cooled Reactors (TWG-GCR)	Vienna	Austria
28 March – 1 Apr 11	<a href="mailto:R.Beaty@iaea.org">R.Beaty@iaea.org</a>	GIF-INPRO Interface Meeting	Vienna	Austria
11-15 April 11	<a href="mailto:K.S.Kang@iaea.org">K.S.Kang@iaea.org</a>	Technical Meeting on Management of Change in NPPs	Vienna	Austria
12-14 April 11	<a href="mailto:J.H.Choi@iaea.org">J.H.Choi@iaea.org</a>	The 2 <sup>nd</sup> Workshop on Good Practice in HWR Operation	Gyeongju	Republic of Korea
26-28 April 11	<a href="mailto:B.M.Tyobeka@iaea.org">B.M.Tyobeka@iaea.org</a>	Technical Meeting on Understanding core-wide fission product release, mechanistic source terms, and isotope migration in HTGRs	Vienna	Austria
27-28 April 11	<a href="mailto:I.Khamis@iaea.org">I.Khamis@iaea.org</a>	TM of Technical Working Group on Nuclear Desalination	Vienna	Austria

## Impressum

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