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## Second International Symposium on Nuclear Power Plant Life Management



*Participants at the conference, Shanghai, China, 15-18 Oct. 2007*

The Second International Symposium on Nuclear Power Plant Life Management (PLiM) was held on 15–18 October 2007 at Shanghai, China in cooperation with China Atomic Energy Authority (CAEA) and China Nuclear National Corporation (CNNC). The objective of the symposium is to emphasize the role of PLiM programmes in assuring safe and reliable nuclear power plant operation.

The IAEA is in a position to be one of the global focal points and drivers of PLiM for long term operation (LTO) programme in Member States. In the 2nd PLiM symposium, about 300 participants from 35 Member States and 3 international organizations participated and 175 papers were submitted to present in keynote, oral and poster sessions. The symposium programme contained 10 keynote speakers, 18 technical sessions, a panel session, a poster session as well as exhibitions on destructive examination, investigation on material degradation, pressurized heavy reactor and software demonstration forums.

Plant life management is the integration of ageing and economic planning to maintain a high level of safety; optimize the operation, maintenance and service life of system structure and components (SSCs); maintain an acceptable level of performance; maximize return on investment over the service life of the NPP and provide nuclear power plant utilities/owners with the optimum pre-conditions for achieving long term operation.



*Mr. Sokolov, Deputy Director General of the IAEA, opening the symposium on 15 October 2007*

Eighteen technical sessions were divided into six categories and programmed as follows:

- Session 1: Approaches to plant life management;
- Session 2: Economics of plant life management;
- Session 3: Ageing management and related operational programme;
- Session 4: System, structure and component design modification, modernization, refurbishment and replacement;
- Session 5: Managerial issues concerned with plant life management;
- Session 6: Regulatory issues concerned with plant life management.

The symposium demonstrated the value of an open exchange of information among experts from different countries and different organizations, especially operation application and components in nuclear power plants. The presentations covered a wide range of subjects from very specific solutions for reactor pressure vessel integrity, material degradation to ageing management and licensing renewal approaches, risk informed inspection, non destructive examination methods and tools to be used in various stages of plant life management programmes.

All information, recommendations and suggestions provided at this symposium through the key note speeches, oral and poster presentations as well as panel discussion is important to improve the related IAEA activities. It is suggested that international efforts should be increased to create a common and comprehensive programme for the development of a module for human resource development in the area of nuclear technology and safety, which also includes ageing management, PLiM and LTO.

These documents are available through the ENTRAC database (<http://entrac.iaea.org/Default.aspx>) which is a comprehensive Web catalogue on training and engineering related information.

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## Message from the Director



This is the last Nuclear Power Division Newsletter in 2007.

This Newsletter started in the autumn of 2004. During the last 3 years it has evolved and its length has now increased to more than 20 pages. This may not be an appropriate size for a

newsletter. Consequently, we are beginning to reduce its length by focusing on items that are really new, and we try to sharpen our message by discussing the added values of our IAEA activities.

The IAEA's budget cycle for 2008-9 starts in January. We have changed our Nuclear Power Programme to give increased focus to three areas: (1) plant life management; (2) support to infrastructure building in countries considering to introduce nuclear power; and (3) technology innovation. Staff resources, including cost free experts (CFEs) provided by our Member States, are

being increased in these areas. This is especially true for (2), where the number of staff members will more than double in 2008, and for (3) where the number of INPRO CFEs is increased by 40% as compared with the beginning of 2007. Most of the manuals for INPRO evaluation methodology have now been released. The results of national assessments and the joint assessment for the closed fuel cycle using fast reactors utilizing INPRO evaluation methodology will be released next year. Most of the 11 collaborative projects on various technical topics are planned to start during 2008.

The staff members of the Division of Nuclear Power are happy to contribute, being a part of global community, to assure the benefit from the use of nuclear power and expect to see in 2008 further progress in the use of nuclear energy to make the world a better place to live. I wish you a happy and successful new year.

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## NPP Instrumentation and Control Technologies

### Cable Ageing Database

Ageing management of I&C components and cables is part of plant life management for long term operation.



*Meeting participants, Toronto, Canada, 28 Oct.-2 Nov. 2007*

This activity can be supported by the considerable amount of international operating experience on cable ageing, if the information is properly captured and structured in a database. OECD/NEA is leading a 5 year project aimed at developing an international database on cable ageing with contributions from twelve OECD/NEA Member States. As an observer, the IAEA representative attended the 3rd Cable Working Group Meeting of the OECD/NEA SCAP Cable Ageing Project, which was held at the OECD NEA Headquarters in Issy-les-Moulineaux, France, on 12-13 September 2007. The general aim of the database is to provide qualified data for an optimized ageing management of cables in nuclear power plants. Priority is directed to data on cables where a degradation, defect or failure could compromise the condition of safe operation or may cause considerable burden regarding outage time, lead time for replacement orders, or resources of qualified maintenance personnel.

### Ageing Monitoring and Modernization of Reactor Protection System I&C

A workshop on Ageing of Nuclear Reactor Protection Systems was held in Beijing, China, from 9 to 13 October 2007. The workshop was attended by 22 participants from six organizations in China. The workshop was hosted by the Institute of Nuclear Energy Technology in Tsinghua University (INET). The four international lecturers covered the following areas:

- Diversity approaches for common cause failure mitigation; digital communication assessment for highly integrated control rooms; and licensing processes;
- Core surveillance using modern in-core monitoring systems; noise diagnostics measurements; data acquisition and evaluation systems; detection and analysis of core anomalies and detector failures;

- Design of fission chambers and self powered neutron detectors; functional requirements and reliability assessment of digital protection systems;
- Safety systems in-core instrumentation diagnostics.

### Modernizing Hybrid Main Control Rooms in NPPs

The IAEA held a Technical Meeting on the potential benefits and challenges related to the integration of analog and digital instrumentation and control systems in hybrid main control rooms. The meeting was held in Toronto, Ontario, Canada, from 28 October to 2 November 2007, hosted by Atomic Energy of Canada Limited (AECL) and co-sponsored by additional 20 organizations from Canada, Japan, and USA.

More than 200 technical experts, managers, and various stakeholders from the field of instrumentation and control, process control, human factors engineering, licensing, education, and computer applications from 21 Member States attended. A total of 86 presentations were delivered, including the keynote and opening speeches. The organizations supporting the meeting included OPG, Bruce Power, ORNL, EPRI, CNSC, and U.S. NRC. The scope of the meeting included the following areas: (1) control room modernization projects; (2) enhanced functionality, safety status, and emergency response; (3) I&C system design, implementation and validation; (4) human factors and performance; (5) training approaches, challenges, issues; (6) licensing and regulator issues and challenges; (7) economic analysis and justification of control room upgrades; and (8) envisioning the future.

### Implementing and Licensing Digital I&C Systems

A technical meeting was held on 26-30 November 2007 at the IAEA Headquarters, Vienna, Austria, to complete two related documents titled Implementing and Licensing Digital I&C Systems and Equipment in NPPs and Avoiding Common-Cause Failures (CCF) in Digital I&C Systems of Nuclear Power Plants, respectively. Twenty-two participants from ten Member States were invited to the five-day meeting. The two documents cover all the relevant issues on the implementation,

testing, licensing, and maintenance of digital I&C systems used in reactor protection and control systems. Special attention was paid to challenges posed by the introduction of computer-based technologies to safety systems, such as common cause failures, their triggering and propagating mechanisms, and preventive measures against CCF. The latter includes solutions for defence in depth, diversity, redundancy, and independence.



*Meeting participants, Vienna, Austria, 26-30 Nov. 2007*

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## **Integrated NPP Life Cycle Management**

### **Guidelines on material sciences of stress corrosion cracking**



*Meeting participants, VIC, Austria, 24-27 September 2007*

A consultants meeting to prepare a new technical report *Guidelines on material sciences of metallic structures for IGSCC and IASCC* was organized on 24–27 September 2007 at Vienna, Austria. Thirteen experts from Brazil, Germany, Japan, Rep. of Korea, Spain, Sweden, Switzerland, United States of America, and OECD-NEA attended to prepare a draft version of the IAEA-TECDOC.

Stress corrosion cracking (SCC) is the term given to crack initiation and sub-critical crack growth of susceptible alloys under the influence of tensile stress and a corrosive environment. SCC is a complex phenomenon driven by the synergistic interaction of mechanical, electrochemical and metallurgical factors. SCC can proceed through a material in either of two modes: intergranular (along the grain boundaries) or transgranular through the grains. Sometimes the modes

are mixed or the mode switches from one mode to the other.

The objective of this report is to provide general descriptions of damage mechanisms for different types systems, structures and components in light water reactors and information on good practices for preventing, mitigating and repairing SCC damages as well as information on related international/national R&D programmes. Operational experience and practices in Member States are also presented in the report.

### **Coordinated research project on review and benchmark of calculation for structural integrity assessment of reactor pressure vessel during PTS**



*Meeting participants, Erlangen, Germany, 19-21 Nov. 2007*

To finalize a document on Good Practices for Assessment of Pressurised Thermal Shock (PTS) in Nuclear Power Plants: Handbook on deterministic evaluation for the Integrity of Reactor Pressure Vessels, a consultants meeting was held on 19-21 November 2007 at Erlangen, Germany with experts from China, Czech Republic, Finland, France, Rep. of Korea, Germany, Slovakia, Russian Federation and EC-JRC. The overall objective of this CRP was to perform benchmark deterministic calculations of a typical PTS regime with the aim of comparing effects of individual parameters on the final RPV integrity assessment, and then to recommend the best practices for their implementation in PTS procedures. This will allow better technical support to NPP operation safety and life management.

### **Project review meeting for Atucha II NPP**

The construction of the Atucha II NPP, a pressurized heavy water reactor (PHWR) with 692 MWe output, was initiated in 1981 with operation originally scheduled for July 1987. However the project was delayed when the construction about 80% was complete. The Government of Argentina decided to complete the construction of the Atucha II NPP. To achieve the finalization of construction and preparation for commissioning, the IAEA is providing direct services through organizing workshops and implementing expert missions related to project management and preparation of engineering documents. About 1500 workers and 350 engineers are



working at the site and a lot of activities inside reactor building are progressing.



*Meeting participants, Atucha, Argentina, 29-30 Oct. 2007*

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## Nuclear Power Plant Maintenance

### IAEA workshop on data analysis of steam generator eddy current testing



*Workshop participants, Wuhan, China, 21-23 August, 2007*

A national workshop on Data Analysis of Steam Generator Eddy Current Testing for Nuclear Power Plant was organized on August 21-23, 2007 at Research Institute of Nuclear Power Operation (RINPO) in Wuhan, China. The workshop was successful in disseminating and exchanging information on steam generator degradation mechanisms, new data acquisition probes, data analysis and project management. The workshop covered all the three types of steam generators for PWR, CANDU, and WWER, which China has already had. Topics include the following:

- Steam generator tube degradations and mechanisms.
- Data analysis skills of PWR, CANDU and WWER steam generators;
- Advanced eddy current testing (ET) probes and data analysis;
- Project management and field execution of steam generator tube ET service on a single site and multiple sites;
- ET qualification;
- Experience in technology transfer and localization.

There were 33 participants from 10 NPP operating organizations and technical support organizations of China. The IAEA invited 3 lecturers from Canada, Croatia and Japan. Two practical demonstrations of both

data analysis with field data and data being collected with novel probes were performed by Japanese experts and Croatian expert.

### Technical meeting on water chemistry of NPPs



*Meeting participants, Moscow, Russia, 1-3 Oct. 2007*

A technical meeting on Water Chemistry of Nuclear Power Plants was organized from 1 to 3 October 2007, at Moscow World Business Centre, Moscow, Russian Federation. About 50 specialists from 17 countries participated in the meeting. This meeting was successful in exchanging the information of research results and achievements, plant operational experiences and related issues of WWER/PWR/CANDU plants, among engineers and researchers in utilities, manufacturing and service companies, research institutes and universities throughout the world. The following topics were covered:

- Primary chemistry operational experience;
- Secondary chemistry operational experience;
- Water treatment and auxiliary systems;
- Chemistry and fuel performance issues;
- Decontamination and waste management.

A draft IAEA guidance document on WWER water chemistry was presented and many comments were raised to improve the draft. The publication is expected in the 1<sup>st</sup> quarter of 2008.

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## Databases to Support Nuclear Power

### Country nuclear power profiles (CNPP)

A technical meeting on Country Nuclear Power Profiles (CNPP) was held at the IAEA headquarters in Vienna, Austria on 8–11 October 2007. The CNPP website publication consolidates information on the nuclear power infrastructures in participating countries, and presents factors related to the effective planning, decision making and implementation of nuclear power programmes that together lead to safe and economic operations.

As a follow-up to a consultants meeting held earlier this year, 20 representatives from 18 Member States participated in the meeting. The experts were from positions in governmental organizations or authorities dealing with nuclear power assessment and energy planning.



*Meeting participants, VIC, Austria, 8-11 October 2007*

The representatives presented an overview on the energy and economic situation and the organization of the electricity sector focusing on current nuclear power issues in Member States.

The plenary discussions focused on suggestions for modifications on the format, contents, dissemination and CNPP development including publication of a booklet which would summarize the CNPP into a two pages for each participating Member State. As results, the updated table of contents for main CNPP and a draft of the booklet were prepared.

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#### **New web based NEPIS database**

The Nuclear Economic Performance Information System (NEPIS) includes detailed NPP annual operation, maintenance with and without outage costs. Users can do analysis and benchmarking with it. This database is sharing between IAEA and Electric Utility Cost Group, USA based on the agreement. It is open for participation to all NPP operators and utilities in the world, which are committed to provide data relevant to the database. Recently, the NEPIS database was updated to a web based application, which will be more effective and convenient to use. A TM is planning to be organized in Dec.10-11, 2007 to discuss the implementation of the new web based database and the development of the two new models: NPP capital costs and staffing cost due to the requests from MS.

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#### **Installation of nuclear power project equipments**

The National Workshop on Oversight of the Installation of Nuclear Power Project Equipment was held on 17–19 September 2007 in Sofia, Bulgaria, hosted by Ministry of Economy and Energy. The workshop was organised within the TC project BUL/4/013: Strengthening the National Nuclear Power Infrastructure.

The objective of the workshop was to familiarize the participants with the principles of oversight of the installation of Nuclear Power Project equipment and to

exchange experiences on oversight process at the recently commissioned NPPs with the similar reactor type as was selected for the Belene project.

Twenty-nine participants attended the meeting. In addition to lessons provided by the IAEA experts, question and answer sessions were held following each of these lessons. Participants appreciated the prompt and comprehensive replies to their requests provided by the experts.

#### **NPP performance evaluation and benchmarking using internationally shared data**



*Meeting participants at Paks, Hungary, 15-19 October 2007*

The Technical meeting on NPP Performance Evaluation and Benchmarking using Internationally Shared Data was held on 15–19 October 2007 in Paks, Hungary.

The meeting was organised within the regional TC project RER 4/027 on Strengthening Capabilities for Nuclear Power Plant Performance and Service Life Including Engineering Aspects.

The purpose was to familiarise the participants with principles and steps necessary for successful benchmarking. After detail explanation of PRIS structure and outputs a lessons were provided how to use PRIS and related IAEA databases, like O&M cost database, for evaluation of nuclear power plant performance by international comparison and benchmarking.

Twenty two individuals from operating utilities, governmental organizations and regulatory authorities from the region of Central and Eastern Europe participated in the meeting. The agenda was divided into three modules:

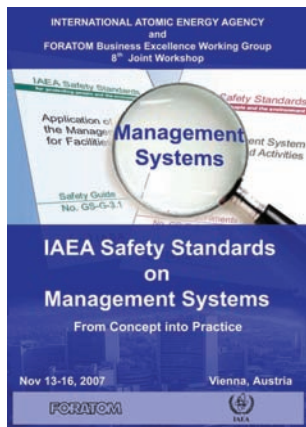
Participants indicated that continuing operating experience exchange and international benchmarking are very important for NPP performance improvement.

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## The 8th IAEA- FORATOM joint workshop on IAEA Safety Standards on Management Systems

A joint IAEA/FORATOM Workshop was organized between 13-16 November 2007, focusing on IAEA Safety Standards on Management Systems. The objective of the workshop was to promote the IAEA safety standards on management systems (GS-R-3, GS-G-3.1. and DS349) and to provide practical information on the transition from traditional QA approach towards the integrated management system in facilities and activities. The workshop focused on the exchange of practical experience from the 37 represented Member States. There were 147 participants registered in the workshop.



The workshop consisted of plenary presentations focusing on main aspects of the key issues and discussions in parallel working groups where all participants were expected to share experiences and lessons learned. The emphasis was on the following key issues:

- Integration of safety, health, environmental, security, quality and economic areas;
- Leadership and safety culture;
- Assessment and improvement of management systems.

In the morning, the sub-issues were addressed through directly related lectures. In the afternoon, five parallel working group sessions facilitated discussion of the issues – including potential difficulties and opportunities. The workshop included a total of 21 presentations and 16 working group sessions. Two demonstrations were organized to show how different IT applications can support the implementation of the integrated management system concept. Summaries of working group discussions were recorded and posted on ENTRAC web: <http://entrac.iaea.org/Default.aspx>.

The workshop achieved its objectives. Participants returned to their respective organisations with significantly increased knowledge about the IAEA Safety Standards. The participants found the workshop very practical. The participants identified difficulties, good practices, and recommendations to the IAEA and FORATOM. Dissemination of this information within the Member States should assist both individuals and organisations in the effective application of the

integrated management system approach promoted by the IAEA Safety Standards.



*Participants at the joint workshop, VIC, Austria, 13-16 Nov. 2007*

There are plans on the way to organize the next workshop, which will take place in the first quarter of 2009.

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## Strengthening Nuclear Power Infrastructures

### Workshop on milestones for nuclear infrastructure development and issues for improving financing nuclear power projects

The introduction of nuclear power opens new challenges to Member States starting nuclear programmes for the first time, and these challenges are connected to the need to support the expansion in the areas such as infrastructure, human, financial and industrial resources.

The IAEA addressed this concern in recent publications such as GOV/INF/2007/2 Considerations to launch a NP programme and NE-Series-Guide NG-G-3.1 Milestones in the Development of a National Infrastructure for Nuclear Power issued in September 2007. All of them reflect the needed change in the focus of the Agency's support and concern. In the current period the support needed by Member States is directed to building up the capabilities of organisations that will be responsible for implementation of nuclear programs.

A Technical meeting /Workshop (TM/WSP) on Milestones for Nuclear Infrastructure Development and Issues for Improving Financing Nuclear Power Projects was held in Vienna, 5-9 November 2007. It was organized by the International Atomic Energy Agency (IAEA) and cosponsored by the Governments of Canada, China, France, India, Japan, Rep. of Korea, Russian Federation, and USA. The meeting was attended by 76 participants from 40 Member States.

The TM/WSP was a forum for Member States to exchange views on the most important infrastructure issues summarised in the Considerations and Milestones documents as well as on financing aspects relevant for countries considering the first NPP.



Meeting participants, VIC, Austria, 5-9 Nov. 2007

The TM/WSP programme allowed participants:

- To discuss a wide range of relevant nuclear infrastructure issues and provide IAEA and supplier countries a better understanding of the concerns and needs of participating Member States;
- To review the effects of infrastructure developments and other related topics upon reducing investment risks and possible actions that may improve prospects for financing NPP projects.

The TM/WSP material is available in the following link:

<http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=33552>

Work has started on the development of a new NE-Series-Report on Assessment of the national nuclear infrastructure development status. The objective is to provide a means of assessment, based on the approach presented in the above mentioned publication NE-Series-Guide NG-G-3.1, to determine the Member State's state of implementation of the national infrastructure areas necessary for an NPP project. The envisaged guidance is aimed to be used consistently either for Member State self-assessment or for an external review if requested.

The development of a Nuclear Energy Series Report on Issues Improving Prospects for Financing Nuclear Power Projects has been initiated. A draft report was presented during the milestone workshop. The report will provide a review and practical approaches to reducing investment risks, and the actions possible that may improve prospects for financing nuclear power projects.

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### **Managing the restarting of delayed nuclear power plants**

The draft report providing guidance on Managing the Restarting of Delayed Nuclear Power Plants was finalized. The guidance addresses specific management issues related with the process of restarting and finalizing the construction of a delayed NPP project. The scope addresses the preparation activities, evaluation of structures and materials preservation, commercial and financial arrangements, licensing and project implementation measures. Target users are senior

managers and engineers from nuclear utilities and from their suppliers and technical support organizations for NPP construction and commissioning. Managers and advisors from governmental organizations such as regulatory bodies will also find useful information. The draft was submitted for approval as a NE-Series-Report and publication is foreseen early 2008.

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### **Responsibilities and competences of the nuclear implementing organizations to initiate nuclear programmes**

The development of a Nuclear Energy Series Guide on responsibilities and competences of the nuclear implementing organizations to initiate nuclear programme has been started. The first consultants meeting was held on 23–25 July 2007. The 2<sup>nd</sup> consultants meeting was organized on 19–21 November 2007. A Technical meeting will be conducted in May 2008 to finalize the report. This document will provide practical guidance on the responsibilities, competences and interfaces by the designated implementing organisation (possible future owner/operator) in a country initiating a nuclear power programme and on the attributes that will enable the future owner operator to achieve these.

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### **Improvements in Training and Performance of NPP Personnel**

#### **Use of various types of simulators for training and engineering purpose**

An IAEA workshop to discuss the use of various types of simulators for NPP personnel training and for engineering purpose was held in Wuhan, China, on 22–25 October 2007. It was organized in the framework of the IAEA Extrabudgetary Programme on the Safety of Nuclear Installations in the South East Asia, Pacific and Far East Countries. Twenty-four participants from China - representing eleven nuclear power operating, research, design and engineering support organizations - took part. Twelve international experts from four countries (Canada, Russian Federation, Spain, and USA) presented the most up-to-date technologies and experience.

The participants discussed such important subjects as status and trends in the nuclear power sector and nuclear training; use of simulators for NPP personnel training and authorization; for NPP simulation-assisted engineering, commissioning and operation support; design, testing and implementation of Digital Control Systems and I&C; modernization of NPPs; verification



and validation of the algorithms and procedures; and establishment of crisis centres.



*Participants at the workshop, Wuhan, China, 22-25 October 2007*

Use of the engineering codes in real-time simulators; severe accident modelling, configuration management of simulators and state-of-the-art simulator development technologies were addressed too. Ten simulator software products including actual simulators and advanced development tools were demonstrated. Presentations and discussions have confirmed the importance of the workshop subjects for the enhancing NPP safety, and for increasing efficiency of the new NPP builds and plant modernizations. A visit to the hosting organization (RINPO) Simulator Centre has shown that the Chinese colleagues are achieving a significant progress in simulator and digital control system development. The IAEA experts were the strong team of professionals willing to share their invaluable experience and knowledge. Feedback received from the Chinese participants at the last day of the workshop has shown that there are many strategic and specific taking-aways from this workshop. It was recommended to continue similar workshops on the national, regional or even inter-regional basis.

### **Training and development in Chernobyl NPP**

Extensive assistance was provided by the IAEA in 2007 to the Chernobyl NPP (ChNPP) in the field of training and development of its site managers and staff. A job competency analysis for the decommissioning management job classifications was performed. The identified competencies are developed through a combination of activities. Four seminars were performed already in 2007.



*Seminar participants, Slavutich, Ukraine, 30 Oct. - 1 Nov. 2007*

They addressed the management competencies required for strategic vision, transition of the organization from operation to decommissioning, establishing appropriate human resource management and training for decommissioning phase, management of contractors, leadership, enhancing safety, and improvement of organizational and human performance.



*During a seminar at Chernobyl NPP, Ukraine, 6-10 Aug. 2007*

Visits of the senior managers and staff to the overseas sites undergoing decommissioning of nuclear facilities were performed, to reinforce knowledge acquired through the seminars and to exchange experience with the peers. Two useful visits were performed in 2007: to the UK / Dounreay site and to the USA / Hanford site. Several expert missions to the ChNPP performed. The outcomes from the IAEA assistance are visible. ChNPP managers and personnel successfully have used the acquired knowledge in transition of the organization to the decommissioning phase, creation of new vision for the management of human resources, and in improvement of the project management.

### **Training and performance of NPP maintenance personnel and contractors**

A technical meeting to disseminate good practices in training and performance of NPP maintenance personnel and contractors was performed on 3–6 November 2007 in Hungary. Paks NPP hosted that meeting.



*Technical meeting participants, Paks, Hungary, 3-6 Nov. 2007*

Thirty-seven participants - representing nuclear power plants, operating organizations' headquarters, training

organizations, NPP equipment vendors, nuclear regulatory authorities, educational institutions - from eighteen countries and IAEA took part. Improvement of maintenance and contractor personnel performance and development of their competence are important sources for further enhancing safety and increasing efficiency of NPPs.

Feedback received from the participants shortly after the meeting has shown that organizations already started to use good practices discussed at the meeting. Participants of the meeting recommended to continue IAEA support in this field, conduct similar meetings on regular basis, and publish a Nuclear Energy series report accumulating good practices in maintenance personnel training.

### **Knowledge management for improvement of plant performance**



*Expert mission to Zaporozhzhie NPP, Ukraine, 26-29 Nov. 2007*

Within the IAEA technical cooperation project UKR/0/009 on Improvement of training system for nuclear power plant maintenance personnel, an expert mission to Zaporozhzhie NPP (Ukraine) was performed from 26 to 30 November 2007 to assist in implementation of a pilot project on Knowledge Management for Maintenance Personnel. Active participation of the Ukrainian personnel representing National Nuclear Generation Company ENERGOATOM and Zaporozhzhie, Khmelnytskyi and Rivne NPPs was achieved. The Zaporozhzhie NPP (ZNPP) personnel, international experts from Canada, UK and USA, and IAEA staff presented experiences in performing knowledge management activities at various NPPs; capturing both explicit and tacit knowledge; employing project management practices for the projects related to knowledge management; achieving management support; and using particular methods, information systems and software tools. IAEA publications, presentations, case studies, discussions and meeting with the ZNPP senior management staff helped analyze good practices and lessons learnt and develop both strategic vision and particular plans. The Ukrainian personnel – under coaching of the international experts and IAEA staff – developed the initial versions of the ZNPP Policy Statement on Knowledge Management, of a work plan

for the pilot project, and the overall structure of a knowledge base.

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## **Coordination of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)**

### **Common user considerations by developing countries for future nuclear power plants**

The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) has developed Common User Considerations by Developing Countries for Future Nuclear Power Plants to facilitate understanding between technology users and holders by conveying users' common needs and requirements to technology holders. A set of requirements listed in this document (referred to as CUC hereafter) defines common characteristics needed and desired by potential users of new NPPs in developing countries for both short-term (2015) and long-term (2050) by covering general technical and economic characteristics of desired NPPs and associated services and support from suppliers and their governments. 54 user or potential user countries were identified as the countries, which the CUC could address, and 35 countries out of them contributed to the development of the CUC through direct discussions, participating in meetings and/or answering questionnaires.

This activity was initiated by visits to 7 typical user countries to discuss with various stakeholders in each country, their considerations and requirements regarding future NPPs: Indonesia (May 7 – 10), Belarus (June 13 – 15), Lithuania (June 18 – 21, together with Estonia and Poland), Bangladesh (June 25 – 28), Egypt (July 9 – 12), Mexico (July 23 – 26) and Malaysia (August 13 -16). These experts included government officials in charge of energy policy and nuclear program, nuclear regulators, researchers from national laboratories and universities, utilities and financial sectors in order to gather varied perspectives regarding deployment of future NPPs in the country. Based on these discussions the draft CUC was established and was presented for review to a consultants meeting (September 5-7). Representatives from the 7 typical user countries and 8 technology holder countries (Canada, China, France, India, Japan, Republic of Korea, Russian Federation and USA) were invited for this preliminary review.

After the revision, a workshop was held in November 27–30 with representatives from 31 user and potential user countries and 8 technology holder countries, and a general agreement was reached on the final CUC.



The CUC identified 94 user requirements in areas of economics and financing, infrastructure and implementation, safety, environment, waste management, proliferation resistance, physical protection and technical specifications. The following issues are generally considered to be the most important:

- Local cost competitiveness,
- Minimization of NPP project risk,
- Proven technology,
- Standardization,
- Reliable operation without unplanned interruption through the entire life cycle,
- A progressive increase in national participation and improvement of national capabilities through technology transfer, and
- Support for licensing and human resources.



*Workshop participants, Vienna, Austria, 27-30 November 2007*

The following issues are also considered to be important, but different countries have different requirements:

- Unit size (MWe),
- Spent fuel management strategy,
- Approach to fuel supply assurance,
- Degree of national participation, and
- Non-electric applications/co-generation.

The CUC is expected to serve as a basis for the development of national user requirement documents by user countries as well as a reference for technology holders to develop suitable NPPs and deploy them in developing countries in the future. The final report of the CUC is expected to be published as an IAEA-TECDOC in early 2008.

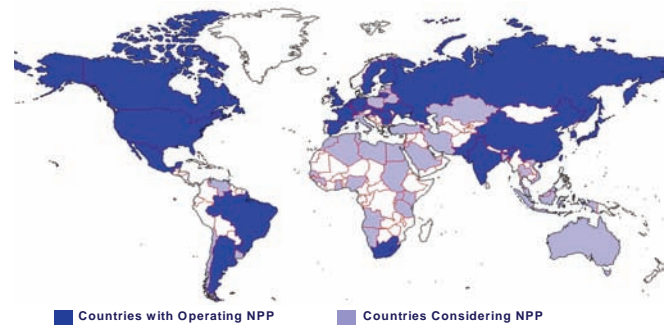
Succeeding to this successful effort, the stage-2 activity will be conducted in 2008 to identify necessary actions to be taken by technology holders and users jointly to fulfill the needs of new users of nuclear power technology.

INPRO Web page: <http://www.iaea.org/INPRO>.

## Advanced Technologies for Water-Cooled Reactors

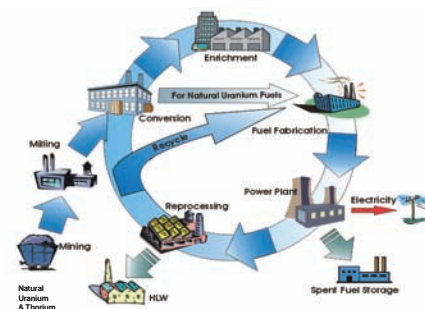
### Technology assessment workshop

As the number of countries considering the deployment of additional nuclear power plants (NPP) is increasing, more Member States have turned to IAEA for information and assistance in the preparation of their NPP programme. An IAEA workshop on Nuclear Power Plant Technology Assessment was conducted in late October 2007 as part of the coordinated effort across the agency in providing such assistance.



*More countries are considering building or expanding nuclear power plant (NPP) programme.*

With the participation of experts and senior officers in the planning of NPP programmes from 25 countries, a large number of lectures were given covering more than a dozen areas of topic in Technology Assessment. Examples of these are the process of conducting Technology Assessment; various considerations that are important to the assessment including those related to fuel-cycle, regulatory/licensing strategy, site selection, grid characteristics, and economics of NPP.



*Fuel-cycle related considerations are important parts of technology assessment. These include fuel cycle options, fuel-cycle facilities, commercial supply of fuel, assurance of fuel supply, and spent fuel management.*

The lectures also cover several other aspects of NPP technologies plant such as constructability, operation and maintenance, evolution of new reactor design features to ensure high performance, development status of new

reactor technologies, and new applications such as desalination, hydrogen production and steam-assisted extraction of oil from oil-sands.



Workshop participants

Lively discussion sessions were also conducted throughout the four-day workshop to address specific issues and concerns related to technology assessment. Several participants presented real cases of technology assessment and national nuclear power planning considerations in Argentina, Brazil, Egypt, Finland, India, Indonesia, Rep. of Korea, Lithuania, Poland, Romania, Ukraine, and USA.

The IAEA is currently extending its effort to prepare a report that can be used as a guideline for conducting technology assessment. Additional workshops on the topic in future years are also being planned.

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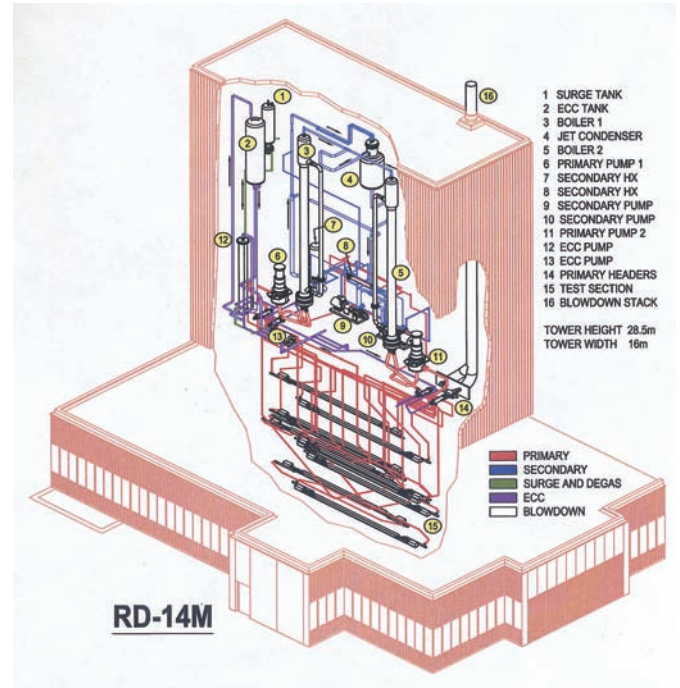
### International collaborative standard problem (ICSP) on heavy water reactor code predictions with SB-LOCA experimental data

The kick-off meeting for the ICSP on HWR code predictions with SB-LOCA experimental data was convened on 14-16 November 2007 at IAEA-HQ. The objectives of ICSP are to improve the understanding of important phenomena expected to occur in SB-LOCA transients, to evaluate code capabilities to predict these important phenomena, their practicality and efficiency, by simulating an integrated experiment, and to suggest necessary code improvements or new experiments to reduce uncertainties.

AECL volunteered to host this ICSP and will provide experimental data collected from RD-14M experiment for SBLOCA scenario. RD-14M is an 11 MW, full-elevation-scaled thermalhydraulic test facility possessing most of the key components of a CANDU primary heat transport system. The facility operates at typical CANDU primary system pressures and temperatures.

In the kick-off meeting, highlights, especially in the area of LOCA analysis, of participating member states or organizations on HWR safety related activities were presented to share the current status, and future plans and needs. The detailed report with the RD-14M facility

description and characterization was distributed and there was active discussion to understand the experimental facility, instrumentation and data acquisition, test procedure, and initial and boundary conditions. Experimental scenarios to simulate and computer codes to be used by each participating institute were determined. According to IAEA procedure for conducting an ICSP, a detailed plan to proceed for future three years was established including both blind and open calculations. Eight institutes from six member states are participating in this ICSP.



RD-14M loop layout (Credit: AECL)

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### Coordinated research programme (CRP) on natural circulation phenomena, modelling and reliability of passive systems that utilize natural circulation

The IAEA is conducting this CRP to enhance understanding of natural circulation phenomena and models in water-cooled reactors and to examine the factors that influence the reliability of passive safety systems that utilize natural circulation.

The 4th Coordination Meeting for the CRP was convened at IAEA-headquarters, Vienna in September 2007. The meeting reviewed ongoing work and updated the Integrated Research Plan including the plans for specific contributions of each participating organization and the schedule for completion of the activities.

Institutes participating in the CRP are collaborating to:

- Report on codes and experiments for phenomena that influence natural circulation;
- Identify and describe reference systems;



- Identify and characterize phenomena that influence natural circulation;
- Examine application of data and codes to design and safety;
- Examine the reliability of passive systems that utilize natural circulation.

Within the CRP, a IAEA-TECDOC on Passive Safety Systems and Natural Circulation in Advanced Water Cooled Nuclear Power Plants is in an advanced stage of preparation; and the final IAEA-TECDOC, entitled Natural Circulation in Water-Cooled Nuclear Power Plants: Phenomena, Modelling, and Reliability of Passive Systems that Utilize Natural Circulation has been planned and will be discussed in detail at the final RCM (to be convened in November 2008).

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### Access to IAEA's thermo-physical properties database (THERPRO)

The Nuclear Power Technology Development Section has established the THERPRO database of thermo-physical properties of materials used in nuclear reactors.

As of the end of November 2007, there are 170 registered users from 38 Member States, representing 108 organizations. THERPRO contains over 13,000 data files for 250 reactor materials, descriptions of experiments, and bibliographic information.

The data base is managed by Hanyang University of the Republic of Korea. To access the THERPRO web site, the potential user should go through the registration process by filling out the registration form <http://therpro.hanyang.ac.kr>.

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### Workshop on Nuclear Power Plant Simulators for Education

The IAEA Workshop on Nuclear Power Plant Simulators for Education was held in November 2007, in cooperation with, and hosted by the International Centre for Theoretical Physics (ICTP) in Trieste, Italy.

The workshop was special in the sense that many of the participants were representatives of educational institutions, regulatory bodies, research and design organisations and specialists who had extensive experience related to water-cooled reactors. The workshop was therefore interactive in nature, with considerable discussion and feedback from the participants themselves.

Participants were provided with instruction and practice in application of reactor simulation computer codes for educational and training purposes. The codes operate on

a PC and simulate the response, to operating and accident conditions, of a number of water-cooled reactor types. The Simulators are designed to provide insight and understanding of the general design and operational characteristics of various power reactor systems, and are used in many educational institutions.



*Workshop participants*

The workshop was conducted in the form of a combination of lectures followed by exercises using the simulators. It covered demonstration and use of seven simulators: a WWER-1000 simulator, two PWR simulators – one with active safety systems and another one with passive safety systems, a BWR simulator, a CANDU simulator (CANDU6) and Advanced CANDU simulator (ACR700), and a TRIGA research reactor simulator. By using the simulators, in combination with the training material, participants investigated and developed an understanding of the operational response characteristics of various reactor types.

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### Technology Advances in Fast Reactors and Accelerator Driven Systems

Activities are conducted with the advice and support of the Technical Working Group on Fast Reactors (TWG-FR), addressing all technical aspects of FR and ADS research and development, design, deployment, operation, and decommissioning. The following summarizes recent progress and plans:

The Project has convened a consultants meeting (Marcoule, France, 24 – 25 October 2007) to prepare the CRP on PHENIX End-of-Life (EOL) Tests centered on experiments planned before the final shutdown of the prototype fast breeder power reactor PHENIX foreseen for 2008–2009. The status of the planning for the PHENIX EOL tests program was presented and discussed. The participants indicated their needs and expectations from the collaborative work to be performed within the framework of the CRP. Finally, a preliminary work plan, including a tentative schedule, was established. The CRP will be implemented in several stages. The first will comprise preparatory

studies in view of the PHENIX EOL tests that are within the CRP scope. In the next stage, the CRP participants will perform blind calculations and post-tests calculations of the benchmarks. The scope of the CRP comprises two PHENIX EOL tests, viz. Control Rod Withdrawal Tests, and Sodium Natural Circulation Tests.

The progress achieved in the Project's CRP on Analytical and Experimental Benchmark Analyses of Accelerator Driven System was reviewed at the 2<sup>nd</sup> Research Coordination Meeting (RCM) of the CRP (Rome, Italy, 12 – 16 November 2007). The participants in the CRP are performing computational and experimental benchmark analyses using integrated calculation schemes. The 2<sup>nd</sup> RCM reviewed, for each of the benchmark activities, the technical specifications, the updated time schedule for producing the results, as well as the responsibilities of the task coordinators and the participants as far as compilation of the results and task documentation are concerned.

In collaboration with ICTP (International Centre for Theoretical Physics), the Project organized the School on Physics, Technology and Applications of Accelerator Driven Systems (ADS) at ICTP, Trieste, Italy on 19–30 November 2007.



*Participants in the IAEA/ICTP School on Physics, Technology and Applications of ADS, 19 – 30 November 2007, Trieste, Italy*

A review of the ADS designs presently under consideration was given. The participants studied the theoretical foundation of all the ADS design aspects (i.e. high-power accelerator, spallation target, and sub-critical blanket), identified the most problematic areas, as well as the limitations of the simulation methods presently used. The students familiarized themselves with the modern theoretical models used to predict nuclear reaction cross sections. They studied the principles of the evaluation methodology and became acquainted with the existing data libraries and the data processing and transport calculations. The School also covered partitioning topics,

advanced fuel design, and, last but not least, the impact of transmutation on the final waste repository.

The School was attended by 31 students from 19 IAEA Member States covering all continents but North America and Australia.

In response to expressed needs by its Member States, the IAEA periodically publishes status reports that provide balanced and objective information about the state-of-the-art, recent results achieved in Nuclear Power Technology Development programs in Member States, and trends for current and future reactor systems and their applications. These reports help Member States considering implementation of nuclear power programs, as well as those with existing programs, to maintain current awareness of advances in technology development throughout the world. More specifically, the Project has published IAEA-TECDOC-985 Accelerator Driven Systems: Energy Generation and Transmutation of Nuclear Waste; Status Report, and IAEA-TECDOC-1083, Status of Liquid Metal Cooled Fast Reactor Technology in 1997 and 1999, respectively. Currently, the project is updating both status reports and has convened back-to-back Consultants meetings (Vienna, 3–7 December 2007) to review the contributions provided so far and to produce the first draft of the respective status reports.

Also in response to the needs expressed by Member States and within a broader IAEA-wide effort in nuclear knowledge preservation, the project is collaborating with INIS/NKM and implementing a concrete initiative on FR data retrieval and knowledge preservation (FRKP). The main goals of this initiative are to halt the ongoing loss of information related to FRs, and to preserve and to make accessible the already existing information. These goals require activities to assist with digital document archival, exchange, search and retrieval, and to facilitate, by using or developing interoperability standards, the knowledge preservation over the next decades. In the framework of the FRKP initiative, the IAEA intends to create a comprehensive international inventory of FR data and knowledge combining information from different Member States through a portal established and maintained by the IAEA. Within this framework, the technical meeting on the Implementation of Fast Reactor (FR) Data Retrieval and Knowledge Preservation Activities was convened in Vienna, 11–14 December 2007. The objectives of this technical meeting were to review the implementation status of the FRKP portal prototype, the availability of the FR related document collections made accessible through the FRKP portal, and to locate new sources of FR related digital items to be made accessible through the FRKP portal. The



technical meeting produced recommendations for refining the FRKP portal's implementation, and identified ways to make the FRKP portal interoperable with Member States' collections of FR related data.

In the period covered by this report, the project presented results of, and progress made with its activities at various international conferences, viz. two papers (IAEA Activities with Accelerators in Areas of Nuclear Interest, in collaboration with IAEA's NAPC Physics Section, and IAEA Coordinated Research Project (CRP) on Analytical and Experimental Benchmark Analyses of Accelerator Driven Systems) presented at the Eighth International Topical Meeting on Nuclear Applications and Utilization of Accelerators (AccApp'07, Pocatello, Idaho, USA, 30 July–2 August 2007); one paper (The IAEA CRP on Studies of Advanced Reactor Technology Options for Effective Incineration of Radioactive Waste) presented at "GLOBAL 2007: Advanced Nuclear Fuel Cycles and Systems" (Boise, Idaho, USA, 9–14 September 2007); and one paper (IAEA Activities in the Area of Research and Technology Development of Fast Neutron Systems, in collaboration with INPRO) presented at the "Tenth ISTC Scientific Advisory Committee Seminar" (Nizhny Novgorod, Russian Federation, 24–28 September 2007).

For more information see

<http://www.iaea.org/inisnkm/nkm/aws/fnss/index.html>.

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## Common Technologies and Issues for Small and Medium Sized Reactors

The IAEA technical meeting on Review of Options to Break the Economy of Scale for SMRs was convened at IAEA Headquarters in Vienna on 15 – 18 October 2007 with 24 participants and observers from 14 IAEA Member States and international organizations. The meeting had the objective to provide a forum for the discussion of the state-of-the-art in approaches for the assessment of SMR competitiveness for different applications and to review materials submitted for the new report on Approaches to Assess Competitiveness of SMRs. The meeting has concluded that considerations of appropriate cost factors indicate that SMR costs can compare favourably with large reactors. These factors include both economy of scale effects and savings for multiple units, series learning, construction schedule, unit timing, and SMR design concept features. With this, SMRs have a potential role to play in the nuclear renaissance. In some cases, they are the only viable nuclear option, where limitations such as smaller grid size, autonomous energy supply areas, lower capacity growth rates or lack of financial resources preclude the

application of large reactors or where non-electric uses are better suited to SMR applications. To take a proper account of economic factors other than economies of scale (learning, multiple unit, design, construction, and timing), levelized unit energy cost (LUEC) models should be linked with a present value capital cost model. For example, if smaller NPP units are constructed sequentially to achieve a targeted overall nuclear power station capacity, with all factors taken into account properly, a higher specific capital cost of a smaller reactor will not necessarily result in a higher LUEC for a combination of such reactors, when compared to a single larger plant of the targeted capacity. The presentations delivered at the meeting are available on a CD from the scientific secretary: [v.v.kuznetsov@iaea.org](mailto:v.v.kuznetsov@iaea.org), upon a request.

A new report titled Passive Safety Design Options for SMRs, mentioned with appreciation in the GC(51)/RES/14/B/2, is reaching the final stage of preparation and is to be submitted for pre-publication clearances by the end of 2007. The overall objectives of this report are to assist designers of innovative SMRs in defining consistent strategies regarding elimination of accident initiators/ prevention of accident consequences by design and incorporation of inherent and passive safety features and passive systems in safety design concepts of such reactors; and to assist potential users of innovative SMRs in their evaluation of the overall technical potential of SMRs. Structured descriptions of passive safety design features for 10 SMR design concepts have been collected from member states and their review in line with a common approach suggested by the IAEA safety standards has been carried out.

A detailed programme proposal for a new Coordinated Research Project (CRP) on Development of Methodologies for the Assessment of Passive Safety System Performance in Advanced Reactors has been shaped up and undergoes a clearance process in at the Agency. This CRP aims on development of a common approach to assess performance of passive safety systems. Such an approach could facilitate design optimization and safety qualification of the future advanced reactors, contributing to their enhanced safety levels and improved economics. The project is expected to pool together efforts of all principal developers of the relevant approaches and methodologies worldwide, and also to attract capable new participants. The CRP is proposed for 4 years (2008–2011) and 10 participants from 8 IAEA member states have already confirmed their intention to cooperate. The CRP will be carried in via broad in-house cooperation, involving the Nuclear Energy Department's Technical Working Groups on Advanced Light Water Reactors (LWRs), Heavy Water

Reactors (HWRs), Gas Cooled Reactors (GCR) and Fast Reactors (FR) of NENP and the Safety Assessment Section and Engineering Safety Section of the Department of Nuclear Safety and Security. Close cooperation with INPRO is foreseen.

A support from Member States to the IAEA's activities for innovative SMRs/advanced reactors was expressed in tabs A/5 (Page 9) and B/2 (Pages 14-15) of the IAEA General Conference Resolution GC(51)/RES/14 of September 2007. To download the resolution, please, go to:

[http://www.iaea.org/About/Policy/GC/GC51/GC51Resolutions/English/gc51res-14\\_en.pdf](http://www.iaea.org/About/Policy/GC/GC51/GC51Resolutions/English/gc51res-14_en.pdf) (English)

## Nuclear Desalination

### Advances in nuclear power process heat applications

The 1<sup>st</sup> Research Coordination Meeting of the Coordinated Research Programme on “Advances in Nuclear Power Process Heat Applications” was held at VIC, Austria, on 24–26 September 2007.

The main objective of the meeting was to review, discuss, and evaluate the work carried out by the participating institutions leading up to this RCM.

Aims of participant's Member States as stated in their proposals are:

- Argentina: develop low cost H<sub>2</sub> production method through investigations of kinetics and mechanics of reactions for the two of the leading long-term methods: iodine-sulfur and iron-chlorine cycles.
- China: focus on HTGR design requirements, coupling, safety and economic aspects of nuclear hydrogen production.
- France: focus on modelling, coupling, and economic assessment of different types of HTR to desalination processes using DEEP, and the mechanism and kinetics of the thermo-chemical reactions.
- Germany: focus on updating the German experience in the area of other Proc. heat applications: coal gasification, oil recovery, oil sands and oil shale, chemical-industrial applications such as direct reduction of iron ore, Al-Oxide production, refining processes, raw gas processing.
- Japan: focus on development of safety design philosophy and system flow sheet to categorize hydrogen production system coupled to HTGR into non-nuclear grade system.
- India: analysis and experimentation on thermo-chemical water splitting processes to produce hydrogen, and on the use of waste heat from HTGR for desalination purposes. Techno-economic evaluation scheme will be evaluated.

- Russian Federation: focus on design of HTGR for nuclear hydrogen production systems, components and coupling schemes, material behaviour under high temperatures, process heat exchanger design and engineering.
- South Africa: assess the feasibility of coupling the Hybrid Sulfur process to the PBMR reactor.
- Syrian Arab Republic: focus on parametric assessment and economics of HTGR coupled to hydrogen production and/or MED/VC desalination process using DEEP.

### Validation, verification and benchmarking of DEEP

A consultants meeting was organized at the VIC on 29 – 30 October 2007. The main objective of the consultants was to set out a work plan to revise, benchmark and validate DEEP (Desalination Economic Evaluation Programme) software. Another important objective is to assess the most suitable approach and methodology to perform benchmarking of the software DEEP. Participants will be requested to present papers dealing with above mentioned topics.

In 1998, DEEP was developed originally by General Atomics under contract. The IAEA DEEP computer code has been widely used by engineers and researchers for preliminary economic evaluation of desalination (by a wide range of fossil and nuclear energy sources, coupled to selected desalination technologies). First validation was made in March 1998 by GA, USA. DEEP have been reviewed/examined by many users, some have already find and point out some defects. Many improvements have been suggested (some have indeed been made) on DEEP.

### Integrated nuclear desalination systems

The first meeting on “Integrated Nuclear Desalination Systems” was held at Chennai, India on December 13-16, 2004. Two further meetings were held in Vienna, Austria on 5-8 December 2005 and 11-14 December 2006. It is now planned to hold the next meeting in Cadarache Nuclear Research Centre of CEA, France. The meeting would again provide opportunity for participation of Member States actively involved in the nuclear desalination activities and considering introduction of nuclear desalination in their countries. This would provide a forum for exchange of up to date information and sharing of experiences amongst the Member States. The meeting could help catalyse the activities in many Member States towards possible deployment of demonstration projects and nuclear desalination plants.



## Nuclear Production of Hydrogen

A technical meeting was organized at the VIC from 5-7 September 2007. The Meeting was envisioned to catalyse the activities in many Member States towards the development and testing of economic evaluation software tool for nuclear hydrogen production such as:

### Canada

The use of nuclear technology for non-electricity related applications is an important aspect of the proposed Generation IV nuclear systems. Canadian emphasis is on high-temperature hydrogen production process developments envelope processes that could use temperatures at the lower end of the temperature range considered for very high temperature reactors (VHTR). Canada supports the High Temperature Electrolysis (HTE) of steam for hydrogen production. The economic viability of all new hydrogen production processes is being assessed at AECL against conventional hydrogen production processes such as steam methane reforming (SMR) and low temperature electrolysis.

### France

The CEA is studying various processes for a future massive hydrogen production using sustainable energy sources (nuclear, high temperature solar, geothermal, biomass). Within this research and development programme, two main areas are of particular interest for CEA: high temperature electrolysis and thermochemical cycles.

The production of clean hydrogen is a key component of the energy chain (i.e. from production to the final uses). But various in-depth studies are needed to evaluate the competitiveness of hydrogen chains to serve the future growing markets (refineries, transport...).

### Germany

One of the most promising "Gen-IV" nuclear reactor concepts is the VHTR representing the nearest-term option of all reference plants selected. The product gas hydrogen may represent no major risk to the nuclear plant, if immediately routed away from the place of generation to its (liquefaction and) storage site. For a chemical plant based on the iodine-sulfur thermochemical cycle, the hydrogen producing section (HI decomposition) could be located further away from the nuclear buildings, since it needs only the lower level of process heat.

### India

The targets for nuclear electricity and nuclear hydrogen generation in India are based on a study of elasticity between UN Human Development Index (HDI) and Per Capita Electricity Consumption (PCEC), as well as Per Capita Oil Consumption (PCOC). India will depend mainly on closed nuclear fuel cycle with large scale thorium utilization. The magnitude of the demand, amounting to nearly seventy times the currently installed nuclear capacity, will call for nuclear reactors with advanced passive safety features that can be located close to population centres, and will have no impact in public domain, arising out of any normal or accident conditions prevailing in the nuclear plant. This scenario may be generally valid globally in the post fossil fuel era.

### Japan

In the phase II of the feasibility study on commercialized fast reactor cycle system performed by Japan Atomic Energy Agency (JAEA), a concept of a multi-purpose fast reactor satisfying various requirements, was studied. A thermal source for hydrogen production is one of the attractive utilization of a fast reactor. A sodium-cooled fast reactor is possible to supply heat at 500°C, and a hydrogen production plant with the thermochemical and electrolytic hybrid method using a sodium-cooled reactor as a thermal source has been studied. A hydrogen production plant system with a sodium cooled reactor has been designed. A feasibility study of a steam methane reforming hydrogen production with a sodium-cooled fast reactor was performed and hydrogen production cost of the plant was estimated to be about \$1.67/kg.

### Republic of Korea

The recent developing technologies to produce nuclear hydrogen based on a VHTR can be categorized into the sulfur iodine(SI) cycle, the hybrid sulfur(HyS) cycle, and others. The SI cycle was studied at General Atomics and demonstrated as an integrated loop at JAEA.

In the cases of the sulfur-iodine and hybrid-sulfur cycles, the material problems of the thermo-chemical components for a sulfuric acid decomposition are an issue due to the high temperature (more than 850 oC) and strongly corrosive environment of this process.

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## New Staff in Nuclear Power Division



**CAHYONO, Agus**

Mr. Cahyono has recently taken up duties in the Nuclear Power Technology Development Section as a member of the International Coordination Group (ICG) of the INPRO project where he is performing duties regarding common user criteria activities, especially by analysing data and formulating requirements with other team members. Mr. Cahyono has 20 years of experience in the nuclear power industry as employee at the National Atomic Energy Agency (BATAN) conducting research and development in different units/centers such as the center for nuclear fuel element, the center for nuclear safeguards technology and the center for reactor and nuclear safety technology.

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**HAYASHI, Hideyuki**

Mr. Hayashi has recently taken up duties in the Nuclear Power Technology Development Section as a member of the International Coordination Group (ICG) of the INPRO project where he is performing duties regarding Task2: Improve methodology and Task3: Develop global vision on large-scale nuclear energy development.

Mr. Hayashi has around 30 years of experience in the field of fast reactor at Japan Atomic Energy Agency (JAEA). His activities have been mainly in analyses of large critical experiments and core design studies for large fast reactors aiming at the commercialization of FRs in Japan.



**KUPCA, Ludovit**

Mr. Kupca has recently taken up duties in the Nuclear Power Engineering Section as a nuclear engineer where he will assist in the implementation of the IAEA's activities on engineering support focusing on plant life management and maintenance related to direct assistance and advice to Member States. Mr. Kupca has 12 years of experience in the nuclear power industry, initially as nuclear safety inspector at the Slovak Nuclear Regulatory Authority and later as specialist of design administration at the Department of technical modifications at the Slovak Electricity Company.

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## Meetings in 2008

Start Date	End Date	Title	Location	Country
07 Jan	09 Jan	TM of the International Nuclear Desalination Advisory Group (INDAG)	VIC	Austria
06 Feb	07 Feb	TM of the DEEP Users' Group	VIC	Austria
03 Mar	06 Mar	8th Gulf Water Conference "Water in the GCC - Towards an Optimal Planning and Economic Perspective"	Manama	Bahrain
01 Apr	03 Apr	TM on status of H2 production processes and associated development including safety issues	VIC	Austria
07 Apr	11 Apr	Standing Advisory Group on Nuclear Energy	VIC	Austria
07 Apr	10 Apr	TM on objectives of design and technology development for innovative SMRs	VIC	Austria
22 Apr	25 Apr	TM on methods and experiences of heavy component replacements in nuclear power plants	Monroeville, Pennsylvania	United States of America
05 May	09 May	TM on HTGR design and technology	VIC	Austria
19 May	21 May	Regular meeting of the Technical Working Group on Training and Qualification of NPP Personnel (TWG-T&Q)	ACV	Austria
20 May	23 May	RCM of the CRP on Analyses of and Lessons Learned from the Operational Experience with Fast Reactor Equipment and Systems	VIC	Austria
25 May	29 May	7th conference on 'Nuclear Option in Countries with Small and Medium Electricity Grid'	Dubrovnik	Croatia
26 May	29 May	41st Meeting of the Technical Working Group on Fast Reactors (TWG-FR)	VIC	Austria
26 May	29 May	TM to assess intermediate progress in preparation of a new IAEA report "Strategies to Demonstrate Competitiveness of SMRs in World Markets"	ACV	Austria
02 Jun	04 Jun	TM on integrated nuclear desalination systems	TBD	TBD
03 Jun	05 Jun	13th INPRO Steering Committee Meeting	ACV	Austria
23 Jun	27 Jun	Workshop on Natural Circulation Phenomena and Modelling in Water-Cooled Nuclear Power Plants	ICTP Trieste	Italy
01 Jul	03 Jul	RCM of CRP on advances in nuclear power process heat applications	VIC	Austria
28 Jul	30 Jul	TM on information exchange on advances in nuclear desalination technologies	VIC	Austria
25 Aug	28 Aug	TM on non-electric applications of nuclear energy	TBD	TBD
01 Sep	05 Sep	Workshop on neutron fluctuations, reactor noise, and their applications in nuclear reactors	ICTP Trieste	Italy
01 Sep	03 Sep	Advisory meeting with nuclear hydrogen experts	VIC	Austria
15 Sep	19 Sep	TM on HTGR economic analysis	VIC	Austria
22 Sep	25 Sep	RCM of the CRP on Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the MONJU Reactor Vessel	VIC	Austria
13 Oct	17 Oct	TM on Maintaining and Operating the Power Reactor Information System (PRIS) database and its products	VIC	Austria

Start Date	End Date	Title	Location	Country
15 Oct	16 Oct	TM of in-service inspection qualification bodies for NPPs/International Workshop of Qualification Bodies	VIC	Austria
20 Oct	23 Oct	TM on Design Features of Advanced Sodium Cooled Fast Reactors with Emphasis on Economics	VIC	Austria
20 Oct	23 Oct	TM to assess intermediate progress in preparation of a new IAEA report "Strategies to Demonstrate Competitiveness of SMRs in World Markets"	VIC	Austria
28 Oct	31 Oct	Standing Advisory Group on Nuclear Energy	VIC	Austria
02 Nov	05 Nov	Training Workshop on Nuclear Desalination Technology and Economics	TBD	TBD
03 Nov	06 Nov	RCM of CRP on natural circulation phenomena, modelling and reliability of passive systems that utilize natural circulation	VIC	Austria
03 Nov	07 Nov	RCM of CRP on Small Reactors without On-site Refuelling	VIC	Austria
10 Nov	14 Nov	RCM of CRP on conservation and application of HTGR technology	VIC	Austria
17 Nov	20 Nov	TM to review the TECDOC "Options to enhance proliferation resistance and security of NPPs with innovative SMRs"	VIC	Austria
24 Nov	28 Nov	TM on fuel handling systems of sodium cooled fast reactors	Kalpakkam	India
01 Dec	03 Dec	14th INPRO Steering Committee Meeting	VIC	Austria
TBD	TBD	TM on impact of digital instrumentation and control systems on licensing and operating nuclear power plants	Beijing	China
TBD	TBD	Preparatory meeting for the International Conference on Opportunities and Challenges for Water Cooled Reactors in the 21st Century	VIC	Austria
TBD	TBD	RCM of CRP on master curve approach to monitor the fracture toughness of reactor pressure vessel in nuclear power plants	TBD	TBD
TBD	TBD	RCM of CRP on Advanced Surveillance, Diagnostics, and Prognostics Techniques used for Health Monitoring of Systems, Structures, and Components in Nuclear Power Plants	VIC	Austria
TBD	TBD	TM to develop a comprehensive report on the international status and prospects of nuclear power	VIC	Austria
TBD	TBD	RCM of CRP on heat transfer behaviour and thermo-hydraulics code testing for supercritical water cooled reactors	TBD	TBD
TBD	TBD	Workshop on PC based reactor simulator tools for education	TBD	TBD
TBD	TBD	RCM of the CRP on Analytical and Experimental Benchmark Analyses of Accelerator Driven Systems (ADS)	TBD	TBD
TBD	TBD	TM on Lessons Learned from Large Modernization Projects in I&C Systems	VIC	Austria