



A newsletter of the Division of Nuclear Power  
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## Joint IAEA-EPRI Workshop on Modernization of Instrumentation and Control Systems in Nuclear Power Plants



The first joint IAEA-EPRI Workshop on Modernization of Instrumentation and Control (I&C) Systems in Nuclear Power Plants (NPPs) was held on 3-6 October 2006 in Vienna, Austria. 45 participants from 23 countries attended the workshop and a total of 37 presentations were delivered.

The purpose of the workshop was (1) to provide an opportunity for I&C, control room, and human-system interface experts representing the various stakeholders in the nuclear power industry to get together and share state-of-the-art approaches to modernization of I&C systems and components, control rooms, measurement and information systems; (2) to share nuclear power plant I&C modernization experiences and lessons learned in completed projects; and (3) to provide a forum for interactions and discussions between experts on future I&C modernization challenges and opportunities with a special focus on on-line condition monitoring and the “defense-in-depth and diversity” principle in digital I&C systems. Design, engineering, implementation, and project management issues were presented and discussed. In general, the workshop brought professionals together to share expertise and experiences in order to more effectively modernize I&C systems in operating nuclear power plants.

The workshop included eight international experts giving presentations on I&C modernization projects of nuclear power plants. Four lecturers from EPRI and four from the European Region (Areva, VTT Technical Research Centre of Finland, Paks

NPP, and IAEA) delivered 25 presentations. Additional 12 presentations were given from the audience describing I&C modernization projects performed in certain NPPs. The discussed topics ranged from the complexity, functional capability and failure mechanisms of digital I&C systems to testing the effectiveness and response time of reactor protection systems.

An overview on the I&C subjects of modernizing operating plants and licensing new plants, control room and human-system interface modernization, and the use of visualization technologies was presented. The second block of the agenda included the assessment of digital equipment for safety and high-integrity applications, important analog-to-digital differences, assessment of reliability and dependability by equipment type, and the implementation of the 'defense-in-depth and diversity' principle. In the third block, presentations on on-line condition monitoring included: instrument calibration and the monitoring of processes and equipment, applications of wireless technology, and fleet-wide monitoring.

The following additional subjects were presented and discussed: (1) safety I&C system modernization and digital system applications in WWER-440 plants, (2) the role of I&C systems in power uprating projects, (3) implementing and licensing digital I&C systems and equipment in NPPs, (4) cyber security of NPP instrumentation, control, and information systems, (5) main design steps in I&C modernization projects, (6) experiences gained from various digital I&C projects, and (7) testing the response time and effectiveness of I&C systems used in reactor protection systems.

The examples showed that most of the digital I&C technologies, platforms, and products can be applied both in new NPP designs and in upgrading projects of I&C systems in older operating NPPs.

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## Message from the Director



Welcome to the fourth newsletter of 2006.

Our newsletters have become an excellent method for the Division of Nuclear Power to share information, commentary and schedules of events with our Member States. We have

received excellent feedback from many of you as to how useful the newsletter has been. As with any project or programme and since we are at the end of 2006, I would like to encourage all of our readers to provide any feedback to us as to any improvements we can make to our newsletter. Feedback from all of our readers is an important way for us to provide the best information and knowledge that is meaningful to you and your work. So, please take a few minutes and send us your suggestions for future improvements.

2006 has been an extremely busy year for our division. Many activities, workshops and meetings have been implemented with great success. Many countries without nuclear power have visited the IAEA for assistance to the possibility of a nuclear energy plan. The Technical Cooperation programmes in this area has almost doubled for 2007-8.

The General Conference in September 2006 was focused on providing an introduction to the fifty year celebration of the IAEA and by holding a special event on Assurance of Supply of Fuel. Many Member States' attending this

General Conference stressed the important role to be played by using nuclear power for sustainability.

The Agency's Director General, Mohamed Elbaradei, stated in his opening address "In the aftermath of the Chernobyl accident, the continued viability of nuclear power was viewed with skepticism for almost two decades. But recently we have seen rising expectations regarding the role of nuclear power...sustained nuclear safety and productivity record over the past twenty years has made nuclear operating costs relatively low and stable". He also mentioned "Technological and institutional innovation is a key factor in ensuring the long term sustainability of nuclear power. INPRO addresses issues faced by all countries that choose nuclear power".

With a time of rising expectation to nuclear power we must be vigilant in operations and intelligent in our pursuit of new technologies.

Up to September 2007, there will be more occasions to commemorate the 50 years anniversary of the IAEA. One such occasion that will focus on nuclear energy is a special forum, a symposium, to be held on 11 April 2007 in Aomori, Japan on Global Challenges for the future of Nuclear Energy and the IAEA. This symposium will be held on the second day of the annual JAIF conference by the IAEA in cooperation with the Government of JAPAN and JAIF. The main objective will be to review the 50 year's history of the activities of the IAEA and the

current status of nuclear power in the world and discuss the future vision regarding development and safety of nuclear power and international cooperation. We hope you will join us.

As I close, the staff of the Division of Nuclear Power and I would like to wish you a happy and successful new year.

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## Nuclear Power Plant Operation

### Instrumentation and Control Systems

The consultants meeting on completing the IAEA-TECDOC titled **The Role of I&C Systems in Power Up-Rating Projects in Nuclear Power Plants** was held on 30 August - 1 September 2006, in Vienna with four invited experts. The objective of the report was to provide an overview on I&C modernization projects related to power uprating. The report examines various examples of how improved I&C systems can play a role in the power uprate projects. Also, additional functions and requirements, placed on the I&C systems by the new up-rated operating modes or their secondary effects, are discussed in the report. The IAEA-TECDOC has been finalized and will be submitted for publication in early 2007.

A consultants meeting to further develop the IAEA-TECDOC titled **Implementing and Licensing Digital I&C Systems and Equipment in Nuclear Power Plants** was held on 6-8 September 2006, in Vienna, with six invited experts. The report discusses the two interconnected processes of implementing and licensing digital I&C systems in NPPs. The report has been created as a response to the need of ensuring a smooth interface between the two processes. Experience from various NPP I&C projects has shown that poor handling of the implementation and licensing requirements of new I&C technologies may unnecessarily delay the completion of the project and may increase its cost. The report is both technical and high-level in nature, and is mainly intended for users, who will be involved in managing projects of implementing and licensing digital I&C systems. The report will be finalized at a Technical Meeting in 2007.

A review meeting/workshop on **I&C Cable Ageing Management Programme** was held on 4-6 September in Vienna to review and discuss the I&C cable ageing programme of the Ukrainian NPP industry. Recommendations on cable testing, monitoring and programme management were compiled in a mission report.

A Technical Meeting on **Cyber Security of Nuclear Power Plant I&C and Information Systems** was held on October 17-20 in Idaho Falls, USA, hosted by the Idaho National Laboratory. The meeting was attended by 35 participants from 11 countries, delivering 24 presentations. The objective of the meeting was to

discuss effective measures to ensure computer security by drawing on the collective experience of the meeting participants and to give guidance for personnel with security responsibilities and for computer specialists at nuclear facilities. Experts in all fields of physical protection, nuclear safety, digital I&C and computer security were invited to participate in the meeting. A related IAEA-TECDOC was further developed in three break-out sessions during the meeting. A CD-ROM on the meeting's materials will be issued in early 2007. It will also be available on the IAEA's website. The Idaho National Laboratory also offered the opportunity for the attendees to tour INL's Information Operation Research Center. This facility is home to the Department of Energy's National Supervisory Control and Data Acquisition (SCADA) Test Bed and the Department of Homeland Security's Control Systems Security Center.

The IAEA's I&C activities were presented at the meeting of the IEC TC45 Sub-Committee 45A which was held on 11-13 October in Lyon, France. The close cooperation of the IAEA and IEC in the field of digital I&C systems and applications in NPPs was endorsed by both parties. Activities, working group meetings and publications will be coordinated. Technical areas of mutual interest included upgrading and modernization of I&C systems in NPPs, ageing of I&C components and cables, methods for assessing the performance of safety system instrument channels, common-cause failures, control room modernization, and system surveillance/diagnostics.

The IAEA also co-sponsored the American Nuclear Society's **5th Topical Meeting on Nuclear Power Instrumentation and Control and Human-Machine Interface Technology (NPIC & HMIT)** held in Albuquerque, New Mexico, USA on 12-16 November. The meeting is the largest international meeting on NPP I&C systems and HMI technologies. 203 papers were presented in eight parallel tracks in a total of 47 sessions. The activities of the IAEA on the NPP I&C areas were presented both in the Opening Plenary and the Technical Session on Digital I&C Technology.

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## Nuclear Power Plant Maintenance

From 2005 to 2006, there was a TC regional project RER/4/027: **Strengthening Capabilities for Nuclear Power Plant Performance and Service Life Including Engineering Aspects** for Europe in order to improve NPP reliability and competitiveness; to optimize NPP service life including ageing management and license renewal; to improve management of interfaces with regulator, other organizations and the public. It was successfully implemented. On 1-3 November 2006, the representatives of Europe convened a planning meeting on 2007-08 regional TC programme at the Agency. This project was commended and given an extension of two years. This project will continue to assist the regional NPPs in 2007-08.

As many as 15 technical workshops, technical meetings and training courses were organized in various facilities around Europe in 2006, thanks to the great regional interests and enthusiasms of the region and good co-operation between the Department of Technical Cooperation and NENP. Many of these meetings provided the timely information to the regional NPPs on structural integrity, ageing and plant life management; risk-informed in-service inspection; and I&C modernization and power uprate. These technical topics are exactly in accordance with what the regional NPPs are undertaking, that is, ageing management programme, plant life extension and power uprate, risk informed decision making to optimiser operation and maintenance.

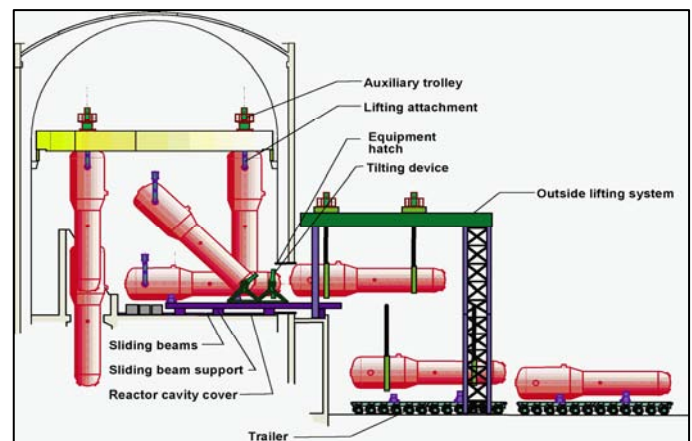
A number of improved technical methods were also introduced, such as: integrated management system which is intended to supersede the QA programme, communication strategies to all the stakeholders, and workforce ageing and knowledge management. These were all well received among the participants.

In addition, a pilot study on **Risk Informed In-Service Inspection for WWER NPPs** was carried out in co-operation with Nuclear Research Institute of Czech republic. The EPRI methodology on RI-ISI was tested on primary piping and pressurizer surge line of WWER-440 Dukovany NPP. 119 welds were assigned to risk category IV and 5 welds to risk category II among a total number of 124 welds per WWER-440 unit. Based on RI-ISI optimization procedure, 12 welds of Category IV and 2 welds of Category II were selected for inspection, while the current inspection programme covers 66 welds. This means a one fourth to one fifth reduction of inspection scope (14 vs. 66 welds), while the safety level is still maintained.

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## Integrated NPP Life Cycle Management

A consultants meeting was held on 8-11 August 2006 at the IAEA to prepare an IAEA-TECDOC on **Methods of the Replacement of Main Components (Steam Generator, Reactor Vessel Head and Reactor Vessel Internal)**. A total of six experts from France (EDF and AREVA-NP), Japan (TEPCO, MHI and Toshiba), USA (Westinghouse) participated in the meeting. The replacement of heavy components is the result of widespread stress corrosion of Inconel 600 (and alloys 82/182) in the primary system. Following the corrosion of steam generator tubes, which led to the first steam generator replacement operations, work has begun on reactor vessel head replacements and pressurizer replacements, pending treatment of the dissimilar butt welds.



The IAEA-TECDOC is dedicated on Heavy Components Replacement considered strategic for plants life management and not included in current maintenance replacement carried out by utilities. The major and heavy components to be considered are:

- Steam Generators for PWR and WWER plants,
- Reactor Vessel Head for PWR plants,
- Reactor Internal Components for BWR plants,
- Reactor Vessel Internals for PWR plants,
- Pressurizer for PWR plants,
- Reactor coolant piping/ recirculation piping PWR and BWR plants.

A consultants meeting on **Review and benchmark of calculation methods for structural integrity assessment of reactor pressure vessels (RPVs) during pressurized thermal shock** was held in the Joint Research Center (JRC) - Institute for Energy(IE) at Petten, Netherlands on 24-26 October 2006 to review the results of benchmark deterministic calculations of a typical PTS regime and to prepare technical report series. A total of ten experts from China, the Czech Republic, Finland, France, Germany, Hungary, the Republic of Korea, Slovakia and JRC- IE participated in the meeting.

Based on commitment at the first research coordinated meeting (RCM) held on November 2005 at the IAEA, each organization submitted and presented the calculation results as shown in Table 1. These main results and experiences from benchmark calculations will be generalized to find the best practices for technical guidelines together with the support of existing data from other projects and the literature. This will substantially contribute to better technical support of NPP operation

- Role of MC shape in evaluation of highly embrittled RPV steels; and
- Evaluation and use of MC data generated under dynamic loading conditions.

The workshop on **Role of Engineering Support in Managing Nuclear Power Plants including System Engineers** under technical cooperation project RAS/4/021 was held at Chashma nuclear power plant on 28-31 August 2006. The purpose of the workshop was to exchange experiences regarding the role of engineering

Table 1. Benchmark calculation results for basic case and national reference code

Organization	National reference code	WWER			PWR		
		Basic case	Nat. ref. doc A)	Nat. ref codes B)	Basic case	Nat. ref codes A)	Nat. ref codes B)
SNERDI, China	ASME Sec. XI				+		+
NRI, Czech Republic	VERLIFE	+	+	+	+		-
FNS, Finland	VERLIFE with modification	+	+	+			
EdF, France	French RSEM code				+		+
AREVA NP, Germany	KTA	+			+	+	+
KFKI, Hungary	VERLIFE	+	+	+	+		
KINS, Republic of Korea	ASME Sect. XI				+	+	+
OKB GP, Russian Federation	MRKR SKhR-2004	+		+	+		
VUJE, Slovakia	VERLIFE	+	+	+			

\* National reference code A : national code approach are used, but postulated crack is the same as the basic case,

\*\* National reference code B : national code approach are used with national requirements on crack definition

safety and life management.

The second research coordinated meeting (RCM) and a consultants meeting on **Master Curve Approach to Monitor Fracture Toughness of Reactor Pressure Vessels in Nuclear Power Plants** were held at Forschungszentrum Rossendorf in Dresden, Germany on 6-10 November 2006. A total of twenty two experts from Belgium, the Czech Republic, Finland, Germany, Hungary, Japan, Rep. of Korea, Mexico, Spain, the Russian Federation, USA, and JRC- IE participated in the meeting. The IAEA has sponsored a series of Coordinated Research Projects (CRPs) that have led to a focus on reactor pressure vessel (RPV) structural integrity application of measured best irradiation fracture parameters using relatively small test specimens. This CRP is follow-up to previous successful CRPs on resolving technical issues associated with application of the Master Curve approach to RPV integrity assessment.

The first RCM for CRP-8 to define the work scope and to prepare test matrix was held in May 2005 at AEKI in Budapest, Hungary and these meetings were the second RCM and CT. National research and experimental results were discussed and collected to the following topics to develop the standardized test methods for measuring dynamic fracture toughness on small specimens.

- Constraint/geometry effects;

support, including examples of the use of system engineers. The focus was on practical, real-plant situations and operating experience from Europe, USA and Rep. of Korea. A total of 30 engineers from China, the Islamic Republic of Iran, Rep. of Korea and Pakistan were joined and the following topics were presented and discussed with experts and participants.

Optimize system performance

- Monitor plant systems and components;
- Plan and implement actions;
- Integrate inputs for management.

Provide technical expertise

- Develop and maintain system expertise;
- Provide regulatory interface for the systems;
- Provide operations and maintenance support;
- Provide modifications support including post mod testing.

Provide problem resolution

- Corrective action programme;
- Plant support.

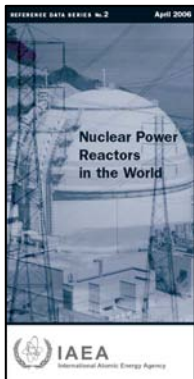
A Technical Meeting on **Power Uprate and Side Effects in Nuclear Power Plants** is to be held on February 15~18 2007 at Oskarshamn, Sweden to provide an international forum to share recent technical knowledge and experience relating to the good practices for the management of power uprate and to share lessons learned

related to side effects on power uprate issues in nuclear power plants. The abstract should be in A4 page not exceeding 500 words and should be sent electronically to the Scientific Secretary, Mr. Ki-Sig Kang not later than **31 December 2006**.

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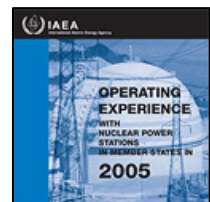
## Databases to Support NPP Performance

A Technical Meeting on **Maintenance and Operation of Power Reactor System (PRIS)** was held on 9-12 October in the IAEA Headquarters to provide information about the current status of the system, its latest development and to get a feedback from PRIS users and data providers. 23 experts from 19 Member States participated in the meeting and work-group sessions. The meeting was structured to review and assess all parts of the system, including its structure, design characteristics, data gathering and dissemination processes and external modules. The recommendations were made with full agreement of all participants of the meeting.



**Nuclear Power Reactors in the World April 2006** Reference Data Series No. 2 was published. This is the twenty-sixth edition of Reference Data Series No. 2, which presents the most recent reactor data available to the IAEA. It contains summarized information as of the end of 2005 on:

(1) power reactors operating or under construction, and shut down; and (2) performance data on reactors operating in the IAEA Member States, as reported to the IAEA. The information is collected by the IAEA through designated national correspondents in the Member States. The replies are used to maintain the IAEA's Power Reactor Information System (PRIS).



**Operating Experience with Nuclear Power Stations in Member States in 2005** was published. This 2006 edition is the thirty-seventh report in the IAEA's series of annual reports on operating experience with nuclear

power stations in Member States. The first publication was issued in 1970. It is a direct output from the IAEA's Power Reactor Information System (PRIS). It contains information on electricity production and overall performance of individual plants during 2005. In addition, the report contains a historical summary of performance during the lifetime of individual plants and figures illustrating worldwide performance of the nuclear industry. The 2006 report was the first such report issued in an electronic version on CD-ROM which provides enhanced features for data searching and analyzing.

A Technical Cooperation Workshop on **Preventive and Predictive Maintenance** was held in Pusan, Republic of Korea on 6-9 October 2006. The purpose of the workshop was to exchange experiences regarding the preventive and predictive maintenance (PM/PdM) programmes and their implementation with emphasis on the practical experience and lessons learned from USA. There were 21 participants from all operating NPPs in



Rep. of Korea. Lecturers from EPRI, Exelon Generation Co. and IAEA provided lectures on:

- IAEA activities supporting PM/PdM
- Concept of Preventive and Predictive Maintenance
- Strategy in US Exelon plants
- PM Basis Database objectives
- PM Basis Database development
- Practical implementation of PM/PdM

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## Management System, Infrastructure and Training

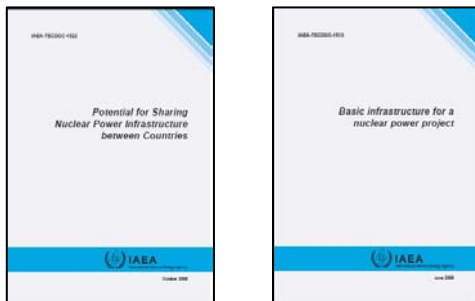
### Strengthening Nuclear Power Infrastructures

The IAEA has been working on **developing guidance related to infrastructure for nuclear power** for several years. The importance of the infrastructure support for a

nuclear power programme was recently recognised by the IAEA Director General in his Statement to the Sixty-First Regular Session of the United Nations General Assembly on 30 October 2006. In part of his statement addressing Nuclear Power Technology, the Director

General, said: *“It is important to note that, as a sophisticated technology, nuclear power requires a correspondingly sophisticated infrastructure. For new countries considering nuclear power, it is essential to ensure that such necessary infrastructure will be available. This infrastructure includes many components - from industrial infrastructure such as manufacturing facilities, to the legal and regulatory framework, to the institutional measures to ensure safety and security, to the necessary human and financial resources. The IAEA recently published guidance on the infrastructure needed for countries to introduce nuclear power, and we are working to define a set of milestones for the development of this infrastructure, to assist us in prioritizing our support for those Member States.”*

The IAEA has recently published two guidance reports on



infrastructure: IAEA-TECDOC 1513 **Basic Infrastructure for a nuclear power project** and IAEA-TECDOC 1522 **Potential for sharing nuclear power infrastructure between countries**. These two reports are available on the IAEA website [www.iaea.org](http://www.iaea.org). The report referred to by the Director General which will define a set of milestones is in development, and was the subject of a Consultants meeting on 7-8 December. This meeting followed the 4-6 December Workshop on Issues for the introduction of nuclear power which was co-sponsored by the Governments of Canada, China, France, India, Japan, the Republic of Korea, the Russian Federation and United States of America. The Workshop was attended by some 100 participants, from 41 Countries, of which 26 do not currently operate nuclear power plants. The workshop provided an opportunity for participants to discuss a wide range of infrastructure issues and to review the issues related to infrastructure needs from their national perspectives, and for the IAEA to better understand the needs and concerns of interested countries.

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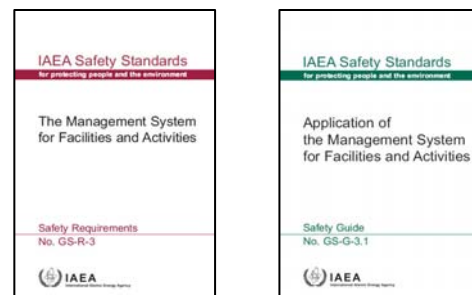
## Strengthening and Harmonizing Quality Management System

The new IAEA Safety Standards GS-R-3 **Safety Requirements on The Management System for**

**Facilities and Activities** and GS-G-3.1 **Safety Guide on Application of Management Systems for Facilities and Activities** were published. The hard copies of the standards can be ordered in Sales and Promotion Unit. International Atomic Energy Agency, Wagramerstrasse 5, P.O. Box 100, A-1040 Vienna Austria. Telephone: +43-1 2600 22529. Fax: +43-1 2600 29302. Email: [sales.publication@iaea.org](mailto:sales.publication@iaea.org). The electronic version of the standards can be downloaded from the following address: <http://www-ns.iaea.org/standards/documents/default.asp?sub=130>

A new draft Safety Standard DS 349 Application of Management System for Nuclear Facilities has been produced and presented to the Safety Standard Committees. The Committees have approved the draft with some comments. After resolving these comments DS349 will be submitted to Member States for their review. The expected publication is early 2007.

## A Technical Cooperation Workshop on Management System for Procurement



A workshop has been organized in Sofia, Bulgaria to address the application of management system for procurement activities. The objectives of the workshop were to provide a forum for exchanging experiences and information on the use of management practices and techniques in procurement activities for the Belene NPP project. The workshop identified common difficulties, possible solutions and good practices to improve overall performance in the area of procurement. There were 22 participants from Bulgaria. The programme was arranged so that in the morning, the sub-issues were addressed through directly-related lectures. In the afternoon, there were several parallel working group sessions with facilitated discussion of the issues – including potential difficulties and opportunities.

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## First application of new IAEA Service on the Enhancement of Management Systems (EMS).

A new service to Member States has been developed that will provide support to nuclear organizations that wish to assure that:

- they have implemented an effective integrated management system

- the mechanisms needed to continuously improve and enhance this system are in place
- the development of a strong safety culture is promoted and supported



This service is based on the new IAEA Safety Standards on integrated Management Systems, GS-R-3 and GS-G-3.1, and support is given on how to implement the new standards, perform self-assessments, enhance and continually improve the management system and culture of the organization.

This service was provided to the Chilean Nuclear Energy Commission (CCHEN), in a Technical Cooperation Workshop in Santiago, Chile. The objectives of this workshop were twofold:

- To aid the development of an integrated Management System implementation by establishing a link between the 'traditional' QM system that was implemented earlier and the new approach of integrated management system.
- To provide training of an assigned assessment team in how to develop and apply self-assessment tools and process, including the knowledge and skills necessary to perform a self-assessment to be used as a baseline for the enhancement efforts.

The workshop identified important issues to resolve in order to successfully implement an integrated management system. Also, self-assessment tools and steps to take in the assessment process were defined. The results of the evaluation of this workshop showed a very high appreciation by CCHEN of workshop content and results. A project plan was developed and the next step in the Agency support to CCHEN is a workshop with management to identify further improvements to be made based on the results of the self-assessment.

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## Effective Training to Achieve Excellence in Human Performance

A seminar for Senior Management Staff of the Ukrainian nuclear power plants, and representatives of operating organization ENERGOATOM as well as Ministry of Fuel and Energy, was performed from 6 to 8 September 2006 at Paks NPP Maintenance Training Centre

(Hungary). That seminar was conducted under the IAEA Technical Cooperation Project UKR/4/012 'Improvement of NPP Maintenance Personnel Training System'; and addressed good Practices in NPP maintenance activities and maintenance personnel training. Twelve managers from Ukraine; and the specialists from Canada, Germany, Hungary, the Russian Federation, USA and IAEA; shared their experience in optimization of maintenance, Reliability Centred Maintenance, Condition Based Maintenance, establishment of maintenance personnel training programmes and facilities.



A Regional Workshop to discuss management of human resources for Senior Management Staff was held on 18-22 September 2006 at Fortbildungszentrum für Technik und Umwelt (FTU) (Karlsruhe, Germany). The workshop was performed under the IAEA Technical Cooperation Project RER/4/027 **Strengthening Capabilities for Nuclear Power Plant Performance and Service Life Including Engineering Aspects**. Fourteen participants from Armenia, Bulgaria, Hungary, Lithuania, Romania, the Russian Federation, Slovakia, Ukraine; and the invited facilitators from Germany, UK and USA; shared their experience in management of human resources, personnel training, knowledge preservation, human performance management, NPP management competence, attraction of new generations of workers and other important subjects. A useful technical visit to Biblis NPP was organized by German colleagues and harmonically fitted into the programme.

A technical meeting to review the drafts of two new IAEA reports - namely **A Manager's Guide for Evaluating Training and the Work Environment to Increase Organizational Performance** and **Management of Nuclear Facility Personnel Training** – is planned on 14-18 May 2007. A specialists meeting on **good practices in training and performance of NPP maintenance personnel and contractors** is planned on 3-6 September 2007.

A technical meeting to review the draft of a new IAEA report on **Training and Human Resource Considerations for Commissioning of Nuclear Power**



**Plants** was held at IAEA Headquarters on 9-12 October 2006. Based upon the comments received during this meeting, the draft is being revised. It will be circulated in early 2007 for review and comment, and is expected to be published in the second half of 2007.

A technical meeting to review the draft of a new IAEA report on **Ethics and Professionalism in Nuclear Industry Organizations** is planned to be held at IAEA Headquarters on 6-8 February 2007.

A Regional Workshop on **Communicating with NPP Stakeholders Regarding Safety and Operations** was held on 16-20 October 2006 at Hosted by the Jozef Stefan Institute, Ljubljana, Slovenia. The workshop was performed under the IAEA Technical Cooperation Project RER/4/027 **Strengthening Capabilities for Nuclear Power Plant Performance and Service Life Including Engineering Aspects**. Participants from

Armenia, Bulgaria, Hungary, Japan, Lithuania, the Republic of Korea, Romania, the Russian Federation, Ukraine; UK and USA shared their experiences on this topic.

The presentations and materials used during the workshops are available to those registered as ENTRAC users.

An upgrade of ENTRAC <http://entrac.iaea.org> has been performed, according to the recommendations of the IAEA Technical Working Group on Training and Qualification of NPP Personnel and using feedback collected from the ENTRAC users. Visit ENTRAC for information or for registration.

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## INPRO Joint Study: A step to enhancing collaboration in Closed Nuclear Fuel Cycle with Fast Reactors

Joint Study on Assessment of an Innovative Nuclear Energy System (INS) based on a Closed Nuclear Fuel Cycle with Fast Reactors (CNFC-FR) is an integral part of the IAEA International Project for innovative reactors and fuel cycle technologies (INPRO). In October 2004 the Russian Federation suggested to assess jointly using INPRO methodology the INS based on a closed nuclear fuel cycle with fast reactors (CNFC-FR). This initiative was supported by some MS. In December 2004 China, France, India, Republic of Korea, Russian Federation, and Japan, as an observer, formed the Joint Study on Assessment of the INS 'CNFC-FR'. In 2005 Ukraine joined the Study; in 2006 Japan and Canada became its participants. To a certain extent, the countries of the Joint Study represent current and future leaders in the technology and they expect other states developing it to join the Study to have holistic global perspective. The Assessment is being carried out in accordance with overall objectives of INPRO and guiding documents of the Joint Study developed and approved by the participating parties. Five meeting of Scientific and Technical Committee of the Study were held in Vienna and in the countries participating in it.

The main objectives of the Joint Study are:

- Assessment of the INS 'CNFC-FR' for satisfying principles of sustainable development.
- Determination of the optimum structure and milestones for the INS deployment at national,

regional, and global levels, and establishment of frameworks.

- Identifying the areas for collaborative R&D work.
- Development recommendations for enhancing cooperation in the areas of mutual interest.



For the time being the first phase of the Joint Study is completed and the study is coming to its final stage. The activity on the first phase included: compilation and analysis of country/region/world context data (national strategies for FR development, selection of scenarios of nuclear power deployment); identification of technologies INS data; determination of tools to be addressed at the stage of INS assessment; collection of proposals capable to increase the INS competitiveness; preliminary determination of promising fields of

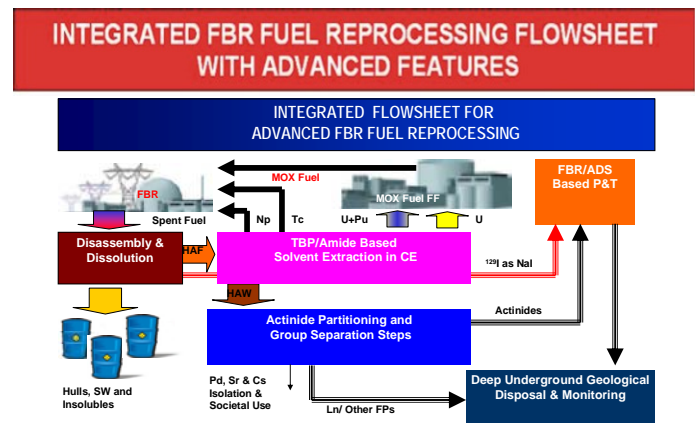
multinational collaboration. Some results of the phase implementation are discussed below.

Overview of national energy strategies has indicated that closed fuel cycle with fast reactors is being considered in countries of the Joint Study with more than half of the world's population as a key component of future sustainable nuclear system capable to provide a global response to global energy challenges in 21st century. Remarkable physics of fast reactors and variety of options for closure of the nuclear fuel cycle makes it possible to adapt the INS 'CNFC-FR' to specific national conditions and realize diverse aspiration of member states. A drastic reduction of reactor waste requiring repository disposal by reducing the amount of uranium, plutonium, and minor actinides in disposal waste is a main incentive for developing of the INS in the countries with a considerable nuclear share in electricity sector and a low, or moderate, expected growth of nuclear capacities (France, Japan, Republic of Korea). In contrast, fuel assurance through achieving high breeding of fast reactors is a driving force for developing of the INS in countries projecting fast growth of nuclear power from low level of installed nuclear capacities (China, India). For Russian Federation where high growth of nuclear power is being planned to be continued from a rather significant level, both waste reduction and fuel assurance are important reasons for deployment of CNFC-FR.

Demonstration of a serial commercial fast reactor of the first generation with a matching fuel cycle that would meet requirements of sustainability is a first important milestone of national programmes. Pilot commercial NPPs with reactor units of installed capacity 500-1800 MW(e) based on the evolutionary improved three-circuit scheme with steam turbine are expected to be built in nearby 15-30 years. Pellet technologies for MOX fuel fabrication as well as advanced aqueous and pyrochemical technologies for reprocessing are the most probable technologies to be used at the initial stages of the period. Utilization of plutonium from spent fuel of these reactors (partial closure of thermal reactors' fuel cycle) is a key task for fast reactors of the first generation. Other options of plutonium and minor actinides management in a system of thermal and fast reactors may also be realized provided that their efficiency for enhancing sustainability is proved. Sodium cooled, pool type fast reactor is being considered by participants of the Joint Study as a sole fast reactor option with a truly perspective to meet INPRO requirements of sustainability, including economic ones, in 15-30 years.

The Joint Study revealed that similarity in strategies of CNFC-FR development at the transition period to its full-scale use is properly added by complementarity of specific national conditions. Indeed, stabilized nuclear

capacities in countries with high maturity of the nuclear infrastructure restrict incentives for fast development of the CNFC. At the same time, orientation only towards own national resources and infrastructure in the countries with high demand in nuclear energy may lead to rather strained situation with assuring the necessary rate of development. The analysis fulfilled has demonstrated a remarkable effect of synergy: while no country of the Joint Study, taken separately, disposes of the full set of factors favouring development of CNFC-FR to the maximum degree (high demand in nuclear energy and electricity, high level of technology and infrastructure maturity, high reserves of plutonium accumulated in SNF), the regional system under consideration does. Thus, the Joint Study confirms expediency of the multilateral approach to the nuclear fuel cycle provided that it would have been extended on MOX fuel and other fuels based on plutonium.



Visualisation of robust INS 'CNFC' as a global energy system of 21st century is being considered by the countries of the Joint Study as second milestone of the system development. Contrary to consistency of national approaches regarding INS 'CNFC' of the first generation, current visions of architecture and technologies for robust INS vary to a considerable degree. Identifying of an INS with a global perspective that will succeed the INS based on a serial fast reactor of the first generation was determined by the Joint Study as a challenging task to be a focal point at the second phase of the Study implementation.

For better understanding the impact of global factors on the performance of the INS, participants of the Joint Study compared the results of national long term studies on nuclear power development with a more generic analysis of global scenarios commissioned by Intergovernmental Panel on Climate Change (IPCC) in a Special Report on Emission Scenarios (SRES). It was established that a healthy multinational market of nuclear fuel under international safeguards would facilitate

unification of the world/regional fleets of nuclear reactors and their technical characteristics.

A lot of commonality in approaches to development of the INS 'CNFC-FR' in forthcoming programmes of countries-participants of the Joint Study creates favourable preconditions for a work on identifying a generic vision of such INS. Some core technical and economic characteristics of the model were defined basing either on operation experience, or on the data of evolutionary designs, or on expert expectations. The first assessment of economics made jointly clearly shows the confidence that CNFC-FR can be realized on cost

competitive basis. The assessments that are being made jointly in the Joint Study recognize R&D direction, which can become basis for collaboration to develop robust and competitive CNFC-FR. Participants of the Joint Study consider the value of the work on a generic INS 'CNFC-FR' not only from the point of view as INS assessment. The advantages of INS unification along with complementarity of national conditions form a great reserve for acceleration the deployment of the system based on CNFC-FR.

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## Technology Developments and Applications for Advanced Reactors

### Common Technologies and Issues for SMRs

On 16 – 20 October 2006, an IAEA technical meeting to **Review enabling technologies for SMRs** was convened in Vienna with 18 experts nominated by the governments of Argentina, China, Croatia, Japan, India, Lithuania, the Republic of Korea, the United States of America, and the NEA OECD. The meeting produced a forum for the discussion of national experience and new initiatives for SMRs (Argentina, China, India, the Republic of Korea, USA, GNEP) and produced several important information updates on relevant developments. The meeting also defined more precisely a new IAEA activity, tentatively titled **Strategies to demonstrate Competitiveness of SMRs in World Markets**, and, as a start-up of this activity, developed a questionnaire to assess the need for SMRs in member states. This questionnaire identifies key parameters relevant to a nuclear power options with SMRs among the statistical and numerical information, desired features or preferences for nuclear power, and national policies in member states. The questionnaire will be elaborated further to develop a country-independent model to re-examine and quantify the need for SMRs in member states, which could be used to maintain a dialogue between possible vendors and potential users of such reactors.

In November 2006, the IAEA Publications Committee approved for publication a new IAEA report **Status of Small Reactor Designs without On-site Refuelling 2007**. The objective of this report is to provide member states, including those just considering the initiation of nuclear power programmes and those already having practical experience in nuclear power, with a balanced

and objective information on important development trends and objectives of small reactors without on-site refuelling, on the achieved state-of-the-art in design and technology development for such reactors, and on their design status and possible applications. The report is intended for many categories of stakeholders, including electricity producers, non-electrical producers, policy makers, designers, and regulators. The main chapters of this report survey emerging energy market characteristics; introduce a rationale for such reactors and review their design and technology development status with a consideration of associated fuel cycle and institutional issues. The annexes provide detailed design descriptions of 30 concepts of small reactors without on-site refuelling, focusing on their potential to provide solutions in the areas of concern associated with future nuclear energy systems.

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### Technology Advances in Water Cooled Reactors for Improvement in Economics and Safety

#### CRP on “Natural Circulation Phenomena, Modelling and Reliability of Passive Systems that Utilize Natural Circulation”

Natural Circulation systems are key to several evolutionary water-cooled designs and many innovative water-cooled reactor designs. The 3rd Research Coordination Meeting (RCM) for this Coordinated Research Project was hosted by CEA, Cadarache on 11-15 September 2006. The meeting was attended by 28 experts from 17 participating institutes in Argentina, Canada, France, Germany, India, Italy, Japan, the Rep. of Korea, the Russian Federation, Switzerland, Spain,

Slovakia, Switzerland, the United States and the European Commission.

The objectives were to review ongoing work, plan collaborative efforts and update the Integrated Research Plan (IRP) that provides an overall structure and schedule for the collaborative research.

Within the CRP there is considerable international sharing and collaboration to.

- Establish the State-of-the-Art on 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, IAEA-TECDOC-1474 **Natural Circulation in Water-Cooled NPPs: Phenomena, Models and Methodology for Reliability Assessment** presenting the status of knowledge has been published and a IAEA-TECDOC on **Passive Natural Circulation Systems in Water-Cooled Nuclear Power Plants** is in an advanced stage of preparation. IAEA-TECDOC-1474 provides considerable technical information basis which is covered in detail in the Course on Natural Circulation in Water Cooled NPPs, which will be convened next at the International Centre for Theoretical Physics (ICTP), Trieste, Italy on 25-29 June 2007.

For the phenomena that influence natural circulation (e.g. behaviour in large pools of liquid, effects of non-condensable gasses on condensation heat transfer; condensation on containment structures, behaviour of containment emergency systems, thermo-fluid dynamics and pressure drops in various configurations, steam-liquid interaction, gravity driven cooling, liquid temperature stratification, behaviour of emergency heat exchangers and isolation condensers, stratification and mixing of boron), participants are working in teams to prepare state of the art reports on the status of experimental data and code assessments for each phenomenon. New, collaborative experiments are being planned at Oregon State University (OSU) to provide data on stability of integral designs to the CRP. Additional data, for example, the ISP-42 data from Paul Scherrer Institute's PANDA facility has been made available to the CRP. Methodology for evaluating the reliability of passive systems, developed in the European Commission's Reliability Methodology for Passive Systems (RMPS) Project has been provided to the CRP. The reliability of CAREM's Passive Heat Removal System will be examined with the RMPS methodology

within this CRP with the support of an IAEA Technical Cooperation Fellowship.

### **National Workshop on "Nuclear Power Plant Simulators for Education" (Bucharest, Romania)**

This Workshop was organized by the IAEA at the request of the Nuclearelectrica SA, Romania, and convened at University Politehnica, Bucharest, under a National Technical Cooperation Project. It was attended by 18 participants. The objective was to train participants in the use of several IAEA NPP Simulators, so that the Simulators can be used in education in Romania.

This Workshop supported the initiative of the Romanian National Consortium for Training and Education in Nuclear Sciences Platform, which is based on a partnership between public and private sectors, bringing together the most important stakeholders involved in Romanian Nuclear Sciences Education and Training: 4 universities, 2 research institutes, 6 professional associations 2 industrial companies and 2 NGOs.

Together with SNN-SA, the following Simulators were selected for this Workshop, to provide an insight and understanding of the general design and operational characteristics of different reactor systems:

- A generic PWR with active safety systems – this Simulator has features similar to PWRs constructed in the 1960s and the 1970s by, for example, Westinghouse, Framatome and KWU, Germany;
- A CANDU – with features quite similar to Cernavoda 1 and 2;
- An advanced CANDU, which is currently under development by AECL, Canada;
- A generic advanced PWR with passive safety systems.

The simulators are designed to provide insight and understanding of the general design and operational characteristics of various power reactor systems. They are not full scope simulators for operator training, nor are they for detailed design or safety analyses. However, they do provide the general response characteristics of HWRs and PWRs, and have very illustrative screens to provide the plant response information in a very interesting way helping to motivate students to learn about nuclear power plants.

The Workshop was conducted by Mr. George Bereznoi, Professor and Dean, School of Energy Engineering and Nuclear Science, Univ. of Ontario Institute of Technology; Mr. Wilson K. Lam from CTI Simulation International Corporation, USA/Canada; Mr. Cliff Po, Microsimulation Technologies, USA; and Ms. A. Badulescu and Mr. J. Cleveland, IAEA.

### **Workshop on Nuclear Power Plant Simulators for Education to be hosted by International Centre for Theoretical Physics (ICTP) in Trieste, Italy**

Initial preparations are underway for the Workshop to be convened at ICTP, Italy from 29 October - 9 November 2007. Participants will receive instruction on IAEA's full fleet of Simulators, which include those listed above (see the Bucharest Workshop), as well as a BWR and a WWER-1000 Simulator. More information on NPP Simulators for Education can be found at the IAEA web site <http://www.iaea.org/NuclearPower/NPTDS/Projects/edu.html>.

### **Collaborative Assessment on The Role of HWRs in the Efficient Utilization of Fissionable Resources**

Following a recommendation by the TWG-HWR in its meeting of 2005 December, an International Collaborative Assessment (ICA) is being launched to assess the "Role of HWRs in the Efficient Utilization of Fissionable Resources". This activity is being organized cooperatively between the Department of Nuclear Energy's Nuclear Power Technology Development Section and the Nuclear Fuel Cycle and Materials Section (which received similar recommendations from the TWG-NFCO and TWG-FPT). The objectives of the ICA are to identify design, engineering and technological advances that can enhance the role of HWRs in improving the utilization of fissionable resource, including possible fuel cycles synergisms among various reactors, and to identify challenges to the materialization of these advances, as well as possible solutions and R&D needs to overcome the challenges.

The ICA is to be completed in three stages, through electronic correspondence with a number of identified experts from a number of relevant Member States and three Consultants Meetings involving some of the experts. The first Consultants Meeting is currently being organized to be hosted from December 11-13 2006 at the Bhabha Atomic Research Centre, Mumbai, India.

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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 collaborated with the Nuclear Fuel Cycle and Materials Section in convening the Workshop (Vienna, 6 – 9 November 2006) on **Low Enriched Uranium Fuel**

### **Utilization in Accelerator-Driven Sub-critical Systems.**

The objective of the Workshop was to define the work plan for a collaborative activity to be implemented within the framework of the Project's ongoing **CRP on Analytical and Experimental Benchmark Analyses of Accelerator Driven Systems (ADS)**.

With the help of senior Russian scientists, the Project has prepared the draft of the publication **Status Report on Lead and Lead-Bismuth Cooled Fast Reactors**. This draft was submitted to an international group of peer reviewers who have delivered a comprehensive review report. To discuss this report's conclusions and recommendations, agree on changes to the draft Status Report and finalize it for publication, the Project convenes a consultants meeting (Vienna, 13 – 14 November 2007) with the contributors to the Status Report and an outside specialist.

In collaboration with IAEA's INIS and Nuclear Knowledge Management Section, the Project is convening a Technical Meeting (Vienna, 28 November – 1 December 2006) on **Implementation of the Fast Reactor Data Retrieval and Knowledge Preservation Initiative** to review national activities in the area of fast reactor data and knowledge preservation, and to develop the requirements and specifications for the Fast Reactor Knowledge Portal to be implemented and maintained by the IAEA.

The Project is holding two back-to-back Technical Meetings (Vienna, 4 – 8 December 2006) on the **Review of the Status of Accelerator Driven Systems R&D and Technology** and on the **Review of the Status of Fast Reactor R&D and Technology**. The main objective of both meetings is to prepare the inputs needed to update the respective IAEA Status Reports, i.e. 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", respectively.

Visit: <http://www.iaea.org/inis/aws/fnss/>.

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### **Technology Advances for Gas Cooled Reactors**

An International Conference on **High Temperature Reactors (HTR-2006)** was held on 1-4 October 2006 in Sandton, South Africa. Organized by the European Network and PBMR of South Africa, it drew some 300 participants and over 200 papers. on the organization of the International Conference on High Temperature Reactors (HTR-2006). The event is a bi-annual activity focused on updating the status of information on high

temperature gas reactor technology and the Agency has again cooperated with the organizers and facilitated the attendance of a few participants from developing countries. A consultants meeting on CRP-7, the IAEA Coordinated Research Project on Potential of High Temperature Gas Cooled Reactors (HTGRs) in Process Heat Applications was held on the sidelines of the conference.

A consultants meeting on **Graphite irradiation creep** is scheduled at the VIC in Vienna (28-30 November 2006) drawing the participation of specialists from several international institutes. The consultants meeting is expected to focus on existing creep data and models and propose new experiments for a better understanding of the important phenomena.

**The next Technical Working Group on Gas Cooled Reactors** is scheduled to take place at the VIC in Vienna (Jan. 15-19) and will focus on reviewing HTGR activities of the Agency and Member States and propose feedback on future activities.

Visit: <http://www.iaea.org/htgr>

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## Support for Demonstration of Nuclear Seawater Desalination

The Final Research Coordination Meeting (RCM) of the IAEA Coordinated Research Project (CRP) on **Economic Research on, and Assessment of, Selected Nuclear Desalination Projects and Case Studies**, was held on 31 October - 3 November 2006, at the IAEA Headquarters, Vienna, Austria. The CRP was launched in February 2002. The main objectives of this CRP were to:

- Evaluate economic aspects and to investigate the competitiveness of nuclear desalination under specific conditions in case studies.
- Identify innovative techniques leading to further cost reduction of nuclear desalination.
- Refine economic assessment methods and tools.

The objectives of the CRP were to be achieved through the following activities:

- Collection and analysis of economic and performance data of various existing desalination plants (size, technology, site, etc.).
- Use of economic evaluation codes and methods.
- Development and improvement of assessment tools and software, including DEEP.
- Assessment of nuclear desalination economics under site-specific conditions.
- Development of a consistent approach for economic assessment of nuclear desalination.

The overall objective of this final RCM meeting was to review, discuss, and evaluate the work carried out by the participating organisations leading up to this RCM. Other objectives include:

- Discussion of specific tasks completed by each participating institution during the fourth year of CRP work and determination of any remaining task to be completed by 2006.
- Discussion of the first draft of the Technical Document detailing the CRP work.

The first complete draft of some of the proposed sections prepared by the Chief Scientific Investigators (CSIs) and the Agency were reviewed and integrated, and the draft was finalized. A brain-storming session was then organized in which the participating CSIs discussed ideas regarding their future work. Many useful suggestions were made regarding the work and activities that could follow the CRP2 at the IAEA. It was unanimously expressed that the end of CRP2 is not the end of the dynamic collaboration that this CRP created among participants.

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## Technology Advances for Non-Electric Applications

Whether for nuclear desalination, nuclear hydrogen production, industrial process heat application, district heating, or other applications, the IAEA is pursuing the effort to harvest the nuclear energy for the benefit of mankind. As a continuation of her activities in the field of non-electrical application, the IAEA is organizing a technical meeting on integrated nuclear desalination systems in Vienna, on 11-14 December 2006. The objectives of the meeting is to provide a forum for exchange of information on the state -of -the -art of deployment of integrated nuclear power- desalination systems; design aspects of nuclear desalination plants, including the reactors, their coupling with the desalination plants, safety and security aspects, consider the techno-economic aspects of nuclear desalination projects/plants, analysis the socio-economic and environmental aspects and public perception of nuclear desalination, and discuss innovations in the reactors and desalination technologies and cost reduction strategies.

The expected outcome of the meeting is to provide a forum for the exchange of current information on the operating desalination plants, existing and planned demonstration projects and feasibility studies leading to deployment of nuclear desalination plants, share knowledge dealing with integrated systems details including the reactors, the desalination systems, their coupling, safety and security aspects and the economics,

assess the socio-economic and environmental aspects and the public perception of such projects, and publish the material submitted to the meeting as a Meeting Report.

In addition, the IAEA is organising an International Conference on **Non-Electric Applications of Nuclear Power: Seawater Desalination, Hydrogen Production and other Industrial Applications** to be held on 16-19 April 2007 in Oarai, Japan. The conference will be organized in cooperation with the OECD Nuclear Energy Agency and the International Desalination Association, and hosted by the Government of Japan through the Japan Atomic Energy Agency

The objective of the conference is to update information on research and development work related to:

- Advances in nuclear hydrogen production and coupling to nuclear power plants
- Advances in nuclear desalination and coupling to nuclear power plants
- Advances in other nuclear process heat applications
- Economic Assessment of process heat applications using alternative energy sources.

The main topics of the conference will focus on the Advances in the design of evolutionary nuclear power

technologies with potential in non-electric applications (Generation IV Small & Medium Reactors and their potential for process heat applications), high-temperature process heat applications of nuclear power ( advances in hydrogen technology systems, coupling aspects of nuclear hydrogen production, economics of nuclear hydrogen production, and advances in other high temperature process heat applications), and on low-temperature process heat applications of nuclear power (advances in desalination technologies, coupling aspects of nuclear desalination, economics of nuclear desalination, and advances in other low-temperature process heat applications).

The conference will consist of plenary sessions for topical areas deemed of general interest. Parallel sessions will be arranged for more detailed technical issues, related to specific applications such as hydrogen, desalination and other topics. There will be keynote presentations by invited speakers at the opening session and a panel at the closing session. Efforts will also be made to organize a poster session in addition to oral presentations.

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## Planned Meetings in 2007

Date	Meeting Title	Location	Country	Scientific Secretary
Jan. 15-19	Meeting of the Technical Working Group on Gas Cooled Reactors (TWG-GCR)	VIC A0742	Austria	Methnani, M.
Feb. 6-8	TM to reinforce the development of attitudes and professionalism of NPP personnel	VIC C07 IV	Austria	Mazour, T.
Feb.12-15	TM on Power Uprate and Side Effects of Power Uprate	Oskarshamn	Sweden	Kang, K.
Feb. 21-23	TM on National NPP Life Management Programmes (TWG-LMNPP)	VIC C07 IV	Austria	Kang, K.
May 14-18	TM on effective management of NPP personnel training to increase organizational performance	TBD	TBD	Kazenov, A.
May 14-18	Meeting of the Technical Working Group on Fast Reactors (TWG-FR)	Tsuruga/Kyoto	Japan	Stanculescu, A.
May 23-25	Meeting of the Technical Working Group on Nuclear Power Plant Control and Instrumentation (TWG NPPCI)	ACV Room L/M	Austria	Glockler, O.
May 29-31	TM on Increasing Power Output and Performance of NPPs by Improved I&C Systems	Prague	Czech Republic	Glockler, O.
Jun 13-15	Meeting of the Technical Working Group on Advanced Technologies for Heavy Water Reactors (TWG-HWR; organized jointly with TWG-LWR)	ACV U1U 633 0	Austria	Cleveland, J.
Jun. 13-15	Meeting of the Technical Working Group on Advanced Technologies for Light Water Reactors (TWG-LWR - organized jointly with TWG-HWR)	ACV U1 U 633 0	Austria	Cleveland, J.
Jul. 2-4	11th INRPO Steering Committee Meeting	VIC C04 BR	Austria	Rao, A.
Sep. 24-28	TM on Lessons learned from large modernization projects in NPP I&C systems	Chatou	France	Glockler, O.
Oct.1-3	TM on Water Chemistry of Nuclear Power Plants (NPPs)	Moscow	Russian Federation	Cheng, H.
Oct. 8-11	TM on Country Nuclear Power Profiles	VIC C07 IV	Austria	Cho, S.

Date	Meeting Title	Location	Country	Scientific Secretary
Oct. 15-18	2 <sup>nd</sup> Interference Symposium on Plant Life Management (PLiM)	Shanghai,	China	Kang, K.
Oct. 15-18	TM to review options to break the economy of scale for SMRs	VIC A0742	Austria	Kuznetsov, V.
Oct. 22-26	Deep User Group meeting	Gran Canaria	Spain	Methnani, M.
Dec. 3-5	12th INPRO Steering Committee Meeting	VIC C02 I	Austria	Rao, A.
2 <sup>nd</sup> Q	TM on Avoiding Common-Cause Failures in Digital I&C Systems	TBD	TBD	Glockler, O.
2 <sup>nd</sup> Q	TM on pro-active management monitoring	VIC	Austria	Vincze, P.
2 <sup>nd</sup> Q	TM on methods for the replacement of main components (steam generator, reactor vessel head, reactor internal)	VIC	Austria	Kang, K.
2 <sup>nd</sup> Q	TM on preparation of the International Symposium on Nuclear Power Plant Life Management (CN-155)	Shanghai	China	Kang, K.
2 <sup>nd</sup> Q	TM on management systems	TBD	TBD	Vincze, P.
3 <sup>rd</sup> Q	TM to disseminate good practices on training and performance of NPP maintenance personnel and contractors	TBD	TBD	Kazenov, A.
3 <sup>rd</sup> Q	TM on Integration of Analog and Digital Instrumentation and Control (I&C) Systems in Main Control Rooms of in Nuclear Power Plants (NPPs)	Mississauga	Canada	Glockler, O.
3 <sup>rd</sup> Q	TM on Development of Benchmarking Processes for Economic Performance Indicators	VIC	Austria	Pieroni, N.
3 <sup>rd</sup> Q	TM on Implementing and Licensing Digital I&C Systems and Equipment in NPPs	TBD	TBD	Glockler, O.
3 <sup>rd</sup> Q	TM on the harmonization of safety standards of management systems	VIC	Austria	Vincze, P.
4 <sup>th</sup> Q	TM on Constructive Relationship Between All the NPP stakeholders: Regulatory, Utility and Supplier Organizations	VIC	Austria	Vincze, P.
TBD	TM on the development of the INPRO methodology to take into account experience of INS assessment in member states and to include breakthrough potential of some INSs to meet INPRO user requirements	VIC	Austria	Moriwaki, M.
TBD	TM on the INPRO methodology in the area of environment for the assessment of non-nuclear energy sources	TBD	TBD	Moriwaki, M.
TBD	TM on the update of the user manual for INPRO methodology	VIC	Austria	Moriwaki, M.
TBD	TM on the development of recommendations for infrastructure changes to support the deployment of INS (in coordination with A.2)	VIC	Austria	Moriwaki, M.
TBD	TM on the adaption of the Life Cycle Assessment (LCA) and Material Flow Assessment (MFA) techniques to the specific requirements of INPRO	TBD	TBD	Moriwaki, M.
TBD	TM on the facilities used for development and testing of innovative technologies in Member States	VIC	Austria	Moriwaki, M.
TBD	TM on case studies on planning and analysis of possible future role of innovative nuclear fuel cycle technologies in global, regional and national context	VIC	Austria	Moriwaki, M.
TBD	TM on the comparison of simulation results for severe transients in HWRs	TBD	TBD	Cleveland, J.
TBD	TM on the implementation of fast reactor data retrieval and knowledge preservation activities	TBD	TBD	Stanculescu, A.
TBD	TM on the preparation of a technical report on emerging designs and deployment challenges of modular HTGR plants	TBD	TBD	Methnani, M.
TBD	TM on Integrated Nuclear Desalination Systems	TBD	Austria	Rao, A.
TBD	TM of the International Desalination Advisory Group (INDAG)	TBD	TBD	Rao, A.
TBD	Advisory meeting with nuclear hydrogen experts	TBD	TBD	Rao, A.