



A newsletter of the Division of Nuclear Power
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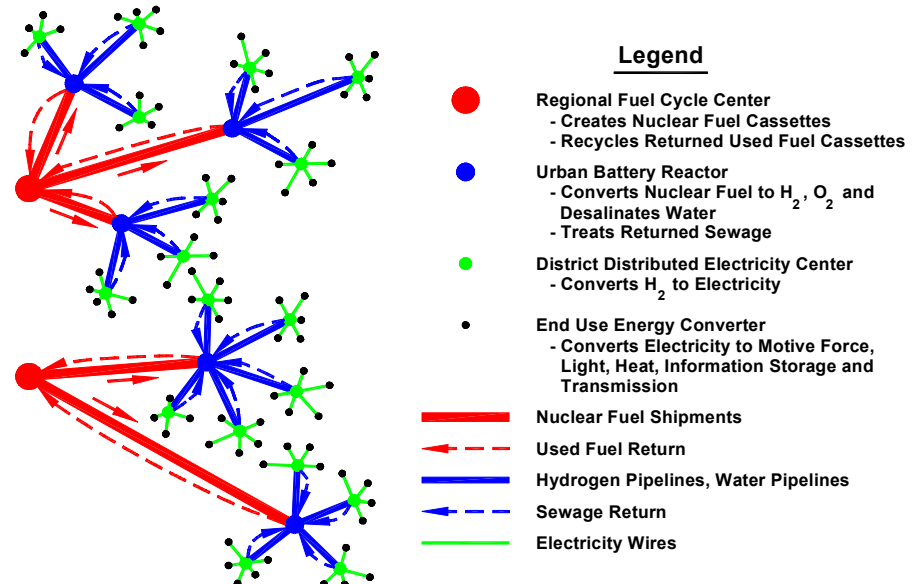
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SMALL AND MEDIUM SIZED REACTORS FOR DEVELOPING COUNTRIES AND REMOTE APPLICATIONS

Small and medium sized reactors (SMRs) are of major interest for many countries with relatively small grid sizes, or limited investment capability, or for remote locations. Nuclear Power Division has a major project directed to the development of understanding the status of the preparation of these reactors worldwide, and also to supporting technical development in this field.



Hierarchical hub/spoke energy architecture as proposed by the Argonne National Laboratory, USA

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One of the distinct trends of design and technology development for innovative SMRs is represented by small reactors without on-site refuelling, which are the reactors that could operate without reloading and shuffling of fuel for a long period, up to 15-25 years and more, with no fresh or spent fuel or the refuelling equipment being present at the site during reactor operation. Such reactors could provide certain guarantees of sovereignty to those countries that would prefer to skip the development of indigenous fuel cycle. One of the examples of SMR coupled with regional fuel cycle centers is shown above.

A technical meeting on **Review of Experience and Options of Validation, Testing and Demonstration of Passive Safety Systems for SMRs** was held on 17-21 October 2005 in Vienna with the participation of 14 experts from 11 IAEA Member States and international organizations. The meeting produced an insight on the currently applied and newly developed methodologies and procedures of validation, qualification and licensing in application to passive safety systems, developed recommendations for a new IAEA TECDOC and defined the scope and schedule of further activities for TECDOC preparation.

A report on **Status of Small and Medium Sized Reactor Designs 2005** have been submitted and approved for publication as IAEA TECDOCs. (Earlier this year a report "Innovative Small and Medium Sized Reactors: Design Features, Safety Approaches and R&D Trends" have been published as IAEA-TECDOC-1451).

A two-week workshop on **Deployment and Application Potential of Integral Type PWRs for Developing Countries** was conducted in Argentina in cooperation with the CNEA. The workshop, attended by 28 participants from 20 developing countries included lectures on the design status and applications of integral type PWRs, with a focus on designs with more advanced development status such as SMART, IRIS and CAREM, and information exchange between all participants regarding energy policy, nuclear energy option, and experience of a developing country in running a nuclear

power. Working material is being prepared based on the presentations and discussions at the workshop.

The first research coordination meeting for a coordinated research project on **Small Reactors without On-site Refuelling** was convened on 21-25 November 2005 in Vienna, to discuss first year reports of 19 participating research institutions from 12 Member States; plans for future coordinated activities have been elaborated. The tasks of the project include examining technological and regulatory approaches to reduce or eliminate emergency planning zone for innovative SMRs, design and technology development for small water cooled reactors with fuel based on coated particle and design and technology development for lead and lead bismuth cooled small reactors without on-site refuelling. The scope of activities will include data exchange, benchmarking, sensitivity analyses, and planning and performance of certain tests.

In addition a report on **Advanced Nuclear Plant Design Options to Cope with External Events** has been approved for publication and will be available as a TECDOC soon. This report addresses the issues of plant design, siting, component qualification and testing, and risk-informed safety assessment regarding extreme external events. Within this report, the designers of 14 advanced NPPs, including several SMRs, discuss and share their experience in addressing external event issues. Contact: V.Kuznetsov@iaea.org.

Message from the Director



Welcome to the 4th Newsletter from the Nuclear Power Division for 2005. I suppose this year of 2005 will be long remembered in the Nuclear Power Division for two reasons.

First of all, we have seen clear indications of rising expectations for the role of nuclear energy to meet mankind's future energy needs. The Paris ministerial conference in March 2005 organized by the IAEA (see the June issue of this Newsletter) sent a strong message to the world that expectation is high from almost every corner of the world. In this conference, a number of developing countries having no operating commercial plants discussed their energy plans including the nuclear power option to alleviate continued reliance on fossil fuels. The Agency

has been discussing its response strategy to the rising expectations that includes energy planning, cooperation for infrastructure building, and for a country's first NPP programme so that it is appropriately reflected in the Agency's programme and budget. As I had noted in the previous Newsletter, very ambitious nuclear power expansion programmes are underway in Asia and Eastern Europe. The US has taken steps to create an environment that encourages investment in the environmentally benign energy options. With regard to nuclear power, the U.S. Energy Policy Act of 2005 includes production tax credits, similar to credits for renewables, for the first 6000 MWe of new nuclear power capacity. Furthermore, there is provision for government standby support for potential delays for up to six reactors.

However, we must understand that those ambitious expansion plans and first NPP projects are not enough to change the big picture in terms of energy dependency on carbon based fuels; the ambitious nuclear expansion in

South and East Asia does not even offset the increase of GHG emission in these areas where the growth of population, economics and the individual's quest for better quality of life really need more energy; which might imply that, besides promotion of efficiency improvements in energy use and renewable energy, a new policy initiative such as lifting of nuclear exclusion in the post-Kyoto era might be required.

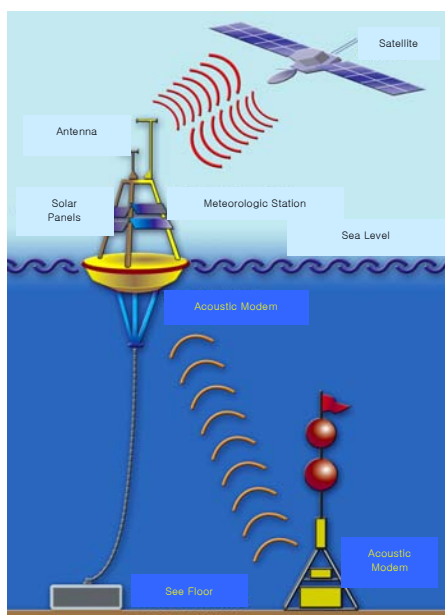
The year of 2005 will also be remembered as a year the Director General and the IAEA received the Nobel Peace Prize. We are very excited by the news. At the same time we feel very humble, because we are encouraged to keep doing what we are doing more effectively with integrity, sincerity and full impartiality to



fulfil the Agency's mandate; working against the misuse of nuclear material for weapon programmes, and ensuring the benefit of nuclear energy for sustainability. I myself had an honour to receive the American Nuclear Society(ANS)'s Presidential Citation on the Nobel Prize in Washington DC on the occasion of the ANS Winter Meeting on behalf of the DG and the IAEA. Again I would like to thank the ANS.

Last but not the least, I would like to wish you health and prosperity in 2006. A.Omoto@iaea.org

INTERNATIONAL WORKSHOP ON EXTERNAL FLOODING HAZARDS AT NUCLEAR POWER PLANT SITES



This international workshop was proposed by the Agency as one of the first responses to the natural disaster that happened on December 26, 2004 in the Indian Ocean and as part of the assessment of the impact of that event on the IAEA programmes. Its

main objective was to convene international experts in the field of external flooding hazards to share information, experiences and good practices related to the occurrences and effects of these types of extreme events on nuclear power plant sites from the regulatory, designer, utility and academic points of view.

From the beginning of its organization, this international workshop received special attention and interest from a

number of organizations and institutions as well as from experts of several Member States. Thus, the number of participants (which was doubled from 40 initially estimated to 79 at the end) and the number of presentations (40) imposed a very tight programme with long sessions. It should be noted that all ocean basin areas were represented at the workshop, including a substantial number of NPPs and sites that could be potentially affected by flooding hazards.

The workshop was structured on the basis of the following sessions, including two invited keynote lecturers and two panel sessions:

- Opening session;
- Experiences and case studies on external flooding hazards;
- Analytical and experimental methodologies for hazard assessment;
- Warning systems and operational safety;
- Regulatory requirements;
- Wrap up and closing session.

For flood hazards, significant lessons have been learned from past events and are incorporated in the current IAEA Safety Standards. Contact: K.S.Kang@iaea.org

Nuclear Power Plant Operating Performance and Life Cycle Management

Continuous Process Improvement of NPP Operation



Technical visit at the full-scope simulator of EdF's Civiux N4 NPP

The Technical Meeting on the **Impact of Modern Technology on NPP I&C Systems** was held in Chatou, France on 13-16 September. The meeting was hosted by EdF and was attended by 65

participants from 19 countries presenting 33 papers. The presentations and discussions focused on the following main areas: (1) Guidelines for NPP control room & human system interface modernization activities, (2) Challenges in licensing digital I&C systems, (3) Implementation of digital nuclear reactor protection systems (4) Use of advanced information technology and communication networks in I&C systems of NPPs, and (5) I&C modernization projects. The program included a technical tour to the full-scope simulator of EdF's Civiux N4 NPP.

A consultancy was held in Espoo, Finland on 29-31 August to initiate a TECDOC on **Implementing and Licensing Digital I&C Systems and Equipment in NPPs**. The meeting was hosted by VTT industrial systems and was attended by 13 participants from 7 countries.

A consultancy was held in Balatonfured, Hungary on 5-8 September to initiate a TECDOC on **the Role of I&C Systems in Power Upgrading Projects in Nuclear Power Plants**. The meeting was hosted by the Paks NPP and was attended by 11 participants from 7 countries.

The Technical Meeting on **Implementing and Licensing Digital I&C Systems and Equipment in NPPs** was held in Espoo, Finland on 22-25 November. The meeting was hosted by VTT and was attended by 85 participants from 24 countries presenting 27 papers. The purpose of the TM was to overview the current practices of implementing and licensing digital I&C systems in NPPs and to discuss new innovative methods and tools to test and validate the implementation and operation of digital systems. In addition, a TECDOC, initiated in August 2005 with the same title, was further developed during the meeting. Contact: O.Glockler@iaea.org

Integrated NPP Life Cycle Management

The consultancy on **Developing Guideline on Ageing Management for Plant Life Management of Nuclear Power Plants** was held from 5 to 7 September 2005 at Vienna International Centre (VIC), Austria. The consultancy aimed at reviewing and refining the first draft of a new Safety Guide on ageing management of NPPs and research reactors, which was created through the first consultancy meeting in July 2005. The most important subjects were to clarify the relation between the power reactor and the research reactor aspects and to create recommendations specifically applied to ageing management of research reactors. To include additional inputs from Member States, the draft Safety Guide was reviewed at the Technical Meeting on "Enhancing safety and performance of nuclear power plants and research reactors through effective ageing management" held on 8-10 November 2005.

The consultancy on **Material Deterioration and Managerial Issues** was held from 17 to 21 October 2005 at VIC. The purpose of the consultancy was to prepare the extended summary report based on the results of Technical Meeting (TM) held on Feb. 2005 at VIC. The material presented at the TM was summarized to prepare the extended summary. The invited experts discussed past and recent incidents in NPPs in terms of both material and managerial issues based on their own experiences and results of the TM. The extended summary was divided into four groups:

- Group 1: Report of incidents,
- Group 2: Technical issues,
- Group 3: Managerial issues,
- Group 4: Regulatory aspects.

The most relevant material from the TM material was selected and prioritized based on importance.

To finalize the extended draft material on **Plant Life Management and Refurbishment - Processes and Technologies for Heavy Water Reactor**, a consultancy was held from 23 to 25 November at AECL Head Office in Toronto, Canada. The specific purpose of the meeting was to prepare the final TECDOC to assist HWR NPP owners/operators with PLiM programs by providing guidance on:

- Typical processes and methodologies in HWR PLiM programs, including plant organization considerations, technology infrastructure and supporting data management,

- Component specific technology considerations for several of the most important HWR systems, structures and components,
- Planning for life management / refurbishment,
- Strengthening the role of proactive ageing management,
- Implementing a systematic ageing management process. The TECDOC will be published in 2006. Contact: K.S.Kang@iaea.org

A consultancy meeting on the preparation of a technical document (TECDOC) on **Verification of WWER Steam Generator Tube Integrity** was held on 14 - 16 November 2005, at VIC. The purpose of the Consultancy meeting was to develop an IAEA publication based on the research results of the CRP titled Verification of WWER steam generator tube integrity. The participants discussed the content of the TECDOC: document objective, scope, structure, most significant points of the document, conclusions and recommendations, relations with existing and future IAEA documents, etc. The title of the TECDOC is rephrased as Strategy for assessment of WWER steam generator tube integrity. The full draft of the TECDOC is expected to be finished early in March 2006. Contact: H.Cheng@iaea.org

Database to Support NPPs

A consultants meeting on **the Country Nuclear Power Profiles (CNPP)** was held on 15 to 18 August 2005 to harmonize the information given on nuclear power infrastructures in Member States with nuclear power

plants in operation and under construction, including those in the planning and implementation stage, and to update the existing CNPP web page. The group reviewed the new profiles from Bangladesh and Poland, and also the existing procedures/approaches of the Agency and the existing structure of the CNPP for collecting and harmonizing updated data from the Member States. The group addressed the issues how to facilitate the information gathering on countries where there are no nuclear programs but there are long-term intentions to develop nuclear programs. Contact: S.K.Cho@iaea.org

A consultancy on **Power Reactor Information System (PRIS) Extension by Component Reliability Data** was held at the IAEA Headquarters in Vienna from 21 to 24 November 2005. The purpose of this meeting was to discuss the idea of development of a new reliability related information database, which could become a new part of PRIS. A new project devoted to this topic has been evaluated from a point of view of usefulness, scope, structure, organization and feasibility. Besides benefits also many drawbacks were pointed out for different options of database development. Evaluating all aspects the group recommended IAEA to consider collaboration with external organisations operating well established component reliability databases. It was also recommended to consider extension of PRIS by Initiating Events (IE) identification as the PRIS database already contains some important information required for IE frequency calculation. Contact: J.Mandula@iaea.org

Improving Quality Management System, Technical Infrastructure and Human Performance

Management System

The draft IAEA **Safety Standards on Management systems**: *The management system for facilities and activities* (DS338) and *Application of the management system for facilities and activities* (DS339) were approved by the final approval body, by the Commission on Safety Standards. The document will be translated into the 5 IAEA official languages and will be published in the second half of the year 2006.

A consultancy on **Management Systems for Nuclear Facilities, DS 349**, was held on 8-10 November 2005 to review the third draft and produce the fourth draft of the new Safety Guide on Management Systems for Nuclear Installations. The Consultancy members all labored to achieve an accord and an effective publication that will serve the needs of all facilities involved in nuclear technology or the regulation thereof. Consensus at the meeting's end was that this had been accomplished. The

draft will be submitted to the Safety Standard Committee in March 2006.

A consultancy on **Management of Organizational Change in Nuclear Utilities** was held on 6-8 September 2005 to review the draft of a guidance document on the management of organizational change in nuclear utilities that includes generic information together with practical examples to aid implementation. A short brainstorming session was organized to finalize the table of contents of the document. Later on the group discussed the general comments provided by the meeting participants and reached an agreement on the general structure of the document. This document is foreseen as a Technical Report Series, which will supersede TECDOC 1226.

A Technical Meeting on **Optimization of Procurement, Handling and Performance of Nuclear Fuel Through Effective Application of Quality Management System** was organized jointly with NSNI and NEFW 15-17

November in Vienna. There were 16 participants from 12 countries. A total of 13 presentations were delivered by the IAEA staff and Member States which opened up discussions in three main areas: Role of the Regulator in Fuel Management, Procurement/ Manufacturing/ Design, and Core/ On Site Fuel Management. Through the discussion sessions the meeting identified the key areas of interest under each topic, and the important relevant issues. There was good and positive contribution from all the members of the meeting and this contributed to the quality of the final output. Contact: P.Vincze@iaea.org.

Strengthening National and Regional Nuclear Power Infrastructures

1. Technical Issues that Influence the Socio-economic and Environmental Implications of Decisions on Operation

Two drafts of guidance documents directed to i) technical issues that influence socio-economic and environmental implications of decision of continued reactor operation or early closure of a NPP, and ii) analytical approach for comparing the implications of extended operation versus early plant closure, were reviewed at a Consultant's Meeting held 3 to 5 October 2005. The drafts were revised in accordance with the Consultant's recommendation and integrated as sections of a single document. The submission of the final draft for publication is scheduled by 15 December 2005. Contact: N.Pieroni@iaea.org

2. Nuclear Power Infrastructure

The 49th General Conference encouraged the Agency's work addressing infrastructure requirements so as to support the introduction of nuclear energy technologies and their safe and efficient use, taking into account relevant economic, social and policy considerations, for those countries that are considering or planning for the introduction of nuclear energy technologies in the 21st. century. (GC(49)/RES/12/G)

A Consultant's Meeting held 14 to 16 September 2005 reviewed and provided recommendations for finalising two technical documents directed to provide guidance on: i) minimum infrastructure necessary to enable Member States to adopt nuclear power, and on ii) potential for sharing of nuclear power infrastructure among countries adopting or extending a nuclear power programme. The documents were revised in accordance with the consultant's recommendations and submitted for final review by a Technical Meeting scheduled 5 to 9 December 2005. Contact: N.Pieroni@iaea.org

3. Delayed Nuclear Power Plants

The Regional Workshop on **Problems and Solutions in Managing Delayed Nuclear Power Plants Projects** was



held 7-11 November 2005 in Constanta Mamaia, Romania. This activity was accomplished under the TC programme RER/4/027 directed to strengthening capabilities for NPP performance and service life, including engineering aspects. The Workshop programme provided a valuable exchange of practical experience from restarted or in the stage of restarting delayed NPPs. Recommendations on further IAEA support activities in this area including the preparation of a technical document on restarting a delayed NPP were produced. Contacts: A.Cardoso@iaea.org; N.Pieroni@iaea.org

Effective Training to Achieve Excellence in Human Performance

During the 49th IAEA General Conference, the representatives from Ukraine suggested an initiative to establish a Center Of Excellence In The Maintenance Activities And Training for the VVER-1000 type NPPs. This Center Of Excellence may be established on the basis of Maintenance Training Center being created at the Zaporozhzhie NPP under the IAEA support (IAEA Technical Cooperation Project UKR/4/012). All parties - which are interested to cooperate and to provide their support - have been invited.

Technical Meeting to develop a technical report on **Upgrade and Modernization of Nuclear Power Plant (NPP) Training Simulators** was performed from 19 to 22 September 2005 in Essen, Germany. That IAEA meeting was hosted by Kraftwerks-Simulator-Gesellschaft mbH. Twenty-eight (28) participants from nineteen (19) countries and IAEA took part in the meeting. Sixteen presentations were delivered. The experience of successful simulator upgrade projects and lessons learnt, specific technical details and effective



management approaches were presented and discussed. It was really a forum for exchange of experience in the field of upgrade and modernization of simulators for the representatives of all interested parties - the NPP operating organizations, regulatory bodies, simulator training centers, and simulator vendors.

A specialists' meeting to disseminate **good practices in the use of training approaches, techniques and tools to increase NPP personnel training effectiveness** was held at the IAEA from 17 to 21 October 2005. Sixty (60) participants attended the meeting (including forty-six participants from sixteen Member States, and fourteen IAEA staff from various departments). Thirty-two presentations and software exhibition covered the vast

majority of the most important areas in NPP personnel training required for ensuring personnel competence and improving human performance. Trends in nuclear power development and in nuclear training; computer-based training systems; e-learning; modern simulator features; education and training for safe and efficient functioning of nuclear industry; various information resources have arisen alive interest of the participants, who persistently requested to continue such kind of activities for sharing experience and benchmarking. Contact: A.Kazenov@iaea.org

In the 2006-07 cycle, there will be a development of Guidelines on Quality Management of NPP Personnel Training. Several consultants' and technical meetings are planned. A technical meeting on this subject will be in Vienna from 19-22 June 2006. The participants from Member States and their organizations (NPPs, training centers, technical support organizations), and also from international entities (such as ISO committees, FORATOM, WANO) are invited to share experience and good practices in the field of managing quality of NPP personnel training and of the associated projects; in continuous improvement of building the personnel competence, and in the integration of training into the entire management systems. Those who are interested to participate, please contact a scientific secretary A.Kazenov@iaea.org.

Technology Developments and Applications for Advanced Reactors

International Collaboration for the Development of Innovative Nuclear Technology

The IAEA's INPRO project is proceeding with the development of a Manual on INPRO methodology for assessment of innovative nuclear energy systems (INSS). Draft chapters, though not all, of the manual in INPRO subject areas have been prepared and sent for review to the members of the INPRO. The six assessment studies of INSS with the use of the updated INPRO methodology, as started by several INPRO members after the 7th meeting of the INPRO Steering Committee, are in progress.

The interface INPRO – IAEA – GIF meeting took place on 20-21 September 2005 at the IAEA with participation of 11 members from

GIF to share information on the progress of activities for Innovative Nuclear Energy Systems and to identify areas for further cooperation. The meeting recognized that GIF and INPRO are complementary to each other, with GIF focusing on R&D. The meeting identified a wide spectrum of topics for potential cooperation in safety, economics, proliferation resistance, sustainability and infrastructure.

The 49th General Conference requested the Director General to strengthen the Agency's efforts related to the

GIF/IAEA/INPRO Interface Meeting
20-21 Sep 2005 Vienna International Center, Austria



development of innovative technologies. (GC(49)/RES/12/F)

The 8th Meeting of the INPRO Steering Committee was held on 5-6 December 2005 in Vienna. The USA became an official member of INPRO and said it is particularly interested in infrastructure-oriented activities. With the participation of Ukraine and the US, now the total number of INPRO member states is 24.

The current status of the four ongoing assessment studies were presented;

- Joint Study (Russia, France, China, India, the Republic of Korea, with Japan as an observer) on closed fuel cycle using Fast Reactor
- France on the transition phase between the current fleet towards the Gen IV fast neutrons systems
- India on hydrogen generation using compact high temperature reactors
- The Republic of Korea on DUPIC Fuel Cycle in the area of Proliferation Resistance

Brazil, Ukraine, Morocco, and Czech Republic announced new assessment studies. Regarding the outline of the next phase (phase 2), a consensus was reached on two of the 3 pillars, namely further improvement of the methodology and work in support of infrastructure development. On the third pillar, namely R&D oriented activities, the Steering Committee recommended that an ad-hoc group should be set up to identify frameworks, options and guidelines for implementation of suitable areas for R&D under Phase 2.

The next Steering Committee Meeting will take place in July 2006 at the VIC to review the report from the ad-hoc group and to consider the start of Phase 2 including action plans.

Contact: F.Depisch@iaea.org, V.Kuznetsov@iaea.org

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

Activities address a broad range of proven means and new approaches for **improving economics of advanced LWRs and HWRs**.

1. Activities on proven means for Improving Economics of Advanced LWRs and HWRs:

Efficient operation / reducing outages: The final RCM for the CRP on **Inter-comparison of Techniques for Pressure Tube Inspection and Diagnostics** was hosted by AECL in Deep River Canada from 17-21 October, 2005. Periodic in-service inspection of Pressure Tubes (PTs) by Non-Destructive Examination (NDE)

techniques is one of the regulatory requirements for HWRs. The objectives of these inspections are to detect, locate and characterize the flaws in PTs and provide information for fitness-for-service assessment. To assure the structural integrity of PTs at all times during service, it is essential to employ NDE techniques that can reliably detect all the 'significant' flaws and characterize them accurately. In order to assess the effectiveness of these techniques for their intended purpose, it is important that they are periodically subjected to 'blind tests' on PT samples containing known flaws. This CRP on 'Inter-comparison of Techniques for Pressure Tube Inspection and Diagnostics' gave the opportunity for the participating laboratories to prepare their own PT samples containing flaws and carry out blind tests on PT samples prepared by others. This CRP has been carried out within the frame of the IAEA Department of Nuclear Energy's Technical Working Group on Advanced Technologies for HWRs (the TWG-HWR).

The objective has been to inter-compare non-destructive inspection and diagnostic techniques, in use and being developed, for structural integrity assessment of HWR pressure tubes. The CRP was broadly divided in two Phases: Phase 1 dealing with flaw characterization by in-situ NDE techniques, and Phase 2 dealing with blister characterization by in-situ NDE techniques and determination of hydrogen concentration in zirconium alloy components. The goal has been to identify the most effective pressure tube inspection and diagnostic methods, and to identify further development needs.

Phase 1 of the CRP was conducted in a round-robin manner. The participating laboratories prepared PT samples containing artificial flaws resembling real defects of concern. The flaws on the outside surface were hidden by a cover to facilitate blind testing. All samples had to be inspected from the inside surface, as in real conditions. The originating laboratory analysed the sample inspection reports from investigating laboratories and compared the NDE flaw sizing estimates with their true values.

For Phase 2, PT samples containing hydride blisters and another set of samples containing known amounts of hydrogen were circulated to the participating laboratories. The results of investigations were analysed to identify reliable and effective techniques for blister characterization and determination of hydrogen concentration in PTs.

During the meeting, two draft TECDOCs were prepared as follows:

Inter-comparison of Techniques for Inspection and Diagnostics of Heavy Water Reactor Pressure Tubes: Flaw detection and characterization: This document

reports the results of the collaboration on flaw detection and characterization (Phase 1 of the CRP); most of the techniques examined in Phase 1 are well established and are regularly used during in-service inspection of PTs. The inter-comparison of these techniques provides a platform for identifying a particular NDE technique (or a set of techniques), which is more accurate and reliable as compared to others for a specified task. The CRP also witnessed some new NDE methodologies, which can be implemented on in-service inspection tools. These new techniques could complement the existing ones to overcome their limitations, thereby improving the reliability and accuracy of in-service inspection. Finally, this TECDOC identifies future areas of research and development and opens up new avenues for technical collaboration within the HWR community to overcome the challenges faced in PT inspection and diagnostics.

Inter-comparison of Techniques for Inspection and Diagnostics of Heavy Water Reactor Pressure Tubes:

Characterization of hydride blisters and determination of the hydrogen concentration in Zirconium alloys: This document reports the results of the collaboration on hydride blister characterization and determination of the hydrogen concentration in Zirconium alloys (Phase 2 of the CRP).

2. Activities on new approaches for Improving Economics of Advanced LWRs and HWRs:

An important new approach incorporated into several evolutionary LWR and HWR designs, and into most innovative LWR and HWR designs, involves use of natural circulation systems. This approach promises to provide improved economics and a very high level of safety through design simplification. Considering the weak driving forces of passive systems based on natural circulation, careful design and analysis methods must be employed to assure that the systems perform their intended function. To foster international collaboration on passive systems that utilize natural circulation, a **CRP on Natural Circulation Phenomena, Modelling and Reliability of Passive Systems that Utilize Natural Circulation** was started in 2004. The first output of this CRP is IAEA-TECDOC-1474 "Natural Circulation in Water Cooled NPPs: Phenomena, Modelling and Methodology for Reliability Assessment". This document presents the current status of knowledge, and forms the basis for an IAEA Course on Natural Circulation in Water-cooled NPPs.

A CRP on **Heat Transfer Behavior and Thermo-hydraulics Code Testing for Super-Critical Water-cooled Reactors (SCWRs)** is being planned to begin in 2006. There is interest in both developing and industrialized countries in SCWRs, primarily because

such systems would achieve higher thermal efficiencies (44-45%) than current evolutionary LWRs and HWRs (34-36%), and thereby have the promise of improved economic competitiveness. Coordination has been agreed with the OECD-NEA. The objectives are to (1) establish a base of accurate data for heat transfer to super-critical fluids; and (2) test computer methods for analyses of SCWR thermo-hydraulic behavior, and to identify code development needs.

On the recommendation of the IAEA Nuclear Energy Department's Technical Working Groups on Advanced Technologies for LWRs and HWRs (the TWG-LWR and TWG-HWR), a collaborative assessment on **Advanced Applications of Water-Cooled Reactors** is being carried out by the Nuclear Power Technology Development Section and the Planning and Economic Studies Section, in cooperation with the OECD-NEA. The first meeting was convened at IAEA-HQ in October. The objective of this activity is to identify opportunities and challenges for water-cooled reactors to capture a substantial share of prospective applications including seawater desalination; district heating; steam for industrial applications including heavy oil recovery; electricity for hybrid electric vehicles; and electricity and heat for hydrogen production. The study is building on results in the following documents: IAEA-TRS-410 on "Market Potential for Non-Electric Applications of Nuclear Energy"; OECD-NEA's report "Non-Electric Products of Nuclear Energy"; and the International Nuclear Societies Council report "Nuclear Production of Hydrogen: Technologies and Perspectives for Global Development".

3. Other Activities – primarily for education

The **Workshop on NPP Simulators for Education** was convened at the International Centre for Theoretical Physics, Trieste, 31 October – 11 November 2005. This



Workshop teaches the use of BWR, PWR, VVER and HWR simulators for university level education. Twenty-one participants from 15 Member States received instruction on use of the Simulators. Interest in this Workshop remains high, as many more application were

received from Permanent Missions than the Workshop can accommodate. Applicants who could not be accommodated at this Workshop have been encouraged to apply for potential subsequent Workshops. Contact: J.Cleveland@iaea.org.

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** (TWGFR), 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 reviewed the first draft of the **Status Report on Lead and Lead-Bismuth Eutectic Cooled Fast Reactors** at a consultancy with Russian specialists from IPPE and the Technical University for Nuclear Power Engineering. After international peer review, it is planned to publish the report in March/April 2006. The status of this activity was presented at the GIF/IAEA/INPRO interface meeting on 20 - 21 September, as well as to DOE's acting program director of the Generation IV Nuclear Energy Systems Initiative during a meeting at IAEA headquarters on 17 November 2005.

The TWGFR Scientific Secretary participated in **AccApp'05** (28 August - 1 September 2005), chaired a session, and presented the paper "IAEA Activities in the Area of Partitioning and Transmutation (P&T)" (accepted for publication in "Nuclear Instruments and Methods"). This was the first conference of the AccApp series to be organized in Europe (by the University of Venice Ca' Foscari, under the auspices of the American Nuclear Society, and in collaboration with various institutions, among which the IAEA).

The TWGFR Scientific Secretary was invited by the organizers of the **XV Economic Forum**, held in Krynica, Poland (7 - 10 September 2005), to participate in the seminar and panel on "Energy Technologies" with a paper on "The Nuclear Power Option". In collaboration with INIS/NKM, the Project prepared a proposal for activities to be implemented jointly within the framework of IAEA's Project on **Fast Reactor Data Retrieval and Knowledge Preservation**. It is proposed to initiate pilot projects (to start with the UK, followed by Japan and France) that would identify existing relevant information/knowledge resources in the respective Member State, examine the compatibility of those resources with the structure of the IAEA fast reactor knowledge preservation system, and test the possibility to

link those resources with the IAEA Fast Reactor Knowledge Portal currently under development.

The Project was given the task of organizing the Opening, and the First Session of **IAEA's 2005 Scientific Forum Nuclear Science: Physics Helping the World** (27 - 28 September 2005). Project staff also acted as Scientific Secretary of the First Session. The Forum's summary report, delivered by its General Chair (Professor Burton Richter from Stanford, 1976 Nobel Laureate in Physics), was very well received by the Plenary of the 49th IAEA General Conference. (<http://www.iaea.org/About/Policy/GC/GC49/ScientificForum/index.html>)

The Project convened a Technical Meeting on **The Decommissioning of Fast Reactors after Sodium Draining**, hosted by the Commissariat à l'Énergie Atomique, Centre d'Études de Cadarache (26 - 30 September 2005). Fifty participants from 9 Member States (Belgium, China, France, Germany, Japan, Kazakhstan, Republic of Korea, the UK, and the USA) attended the TM and heard 20 papers.

The TWGFR Scientific Secretary attended the **GLOBAL 2005 International Conference** (Tsukuba, Japan, 3 - 7 October 2005), presented, on behalf of the participants in the IAEA CRP, the technical paper "IAEA CRP on 'Studies of Advanced Reactor Technology Options for Effective Incineration of Radioactive Waste'", visited various JAEA research facilities, as well as TEPCO's Kashiwazaki-Kariwa nuclear power plant, and, as a member of an IAEA delegation, participated in discussions with high-level representatives from JAEA and Tokyo University, as well as with leading JAEA and TEPCO scientists and managers.

The Project convened the joint IAEA/ICTP Workshop on **ADS Technology and Applications** (17 - 28 October 2005) in Trieste, Italy. The Workshop consisted of



lectures, and computer simulation exercises covering the physics of spallation, physics of sub-critical cores, dynamics properties of sub-critical systems, accelerator technology and design, innovative fuels, partitioning technology, and impact of P&T on final waste repositories. In covering these subjects, the Workshop was able to secure the collaboration of 7 distinguished scientists in the respective fields, in addition to Project

staff. Professor Carlo Rubbia, 1984 Nobel Laureate in Physics, delivered the Workshop's keynote lecture. The 34 attending students came from 19 countries (Algeria, Argentina, Belarus, Brazil, China, Cuba, Czech Republic, Egypt, France, Ghana, Hungary, India, Indonesia, Iran, Netherlands, Nigeria, Peru, Serbia & Montenegro, and Syria). The topic of the Workshop met with a high level of interest on the students' side. Their participation and commitment were remarkable, as was the workload they assumed during the exercise sessions. Eight students (2 from Brazil, 1 from China, 4 from India, and 1 from Serbia & Montenegro) gave good quality presentations of their own R&D work.

In completion of the activities required to achieve the goals of the Agency's 2004-2005 Project and Budget Plan, the Project is preparing the kick-off Research Coordination Meeting of the CRP **Analytical and Experimental Benchmark Analyses of Accelerator Driven Systems** (5 - 9 December 2005), a consultancy meeting in support of the CRP **Studies of Advanced Reactor Technology Options for Effective Incineration of Radioactive Waste** (28 - 30 November 2005), and the kick-off Research Coordination Meeting of the CRP on **Analyses of, and Lessons Learnt from the Operational Experience with Fast Reactor Equipment and Systems** (planned for the first quarter of 2006).

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

Contact: A.Stanculescu@iaea.org.

Technology Advances for Gas Cooled Reactors

A Research Coordinated Meeting (RCM-3) of The IAEA Coordinated Research Project (CRP-6) on **Advances in HTGR coated fuel particle technology**, has been held at the VIC in Vienna (Oct. 17-21, 2005). Progress of ongoing work has been discussed during the meeting and a two-year extension is now pending approval. The next meeting is scheduled for 2007.

The IAEA again cooperated this year with OECD-NEA on their third information exchange meeting on **nuclear hydrogen production**. The meeting was held at JAEA headquarters in Japan (Oct. 5-7, 2005). The IAEA is also cooperating with the European Network on their bi-annual conference on High Temperature Reactors, HTR-2006, scheduled in Pretoria, South Africa for October 2006. For more information, please consult our web page www.iaea.org/htgr. Contact: M.Methnani@iaea.org.

Support for Demonstration of Nuclear Seawater Desalination

The 49th General Conference requested the Director General to note the high priority given by interested Member States to the nuclear desalination of seawater and SMR development in the process of preparing the Agency's Programme and Budget. (GC(49)/RES/12/E)

INDAG Newsletter # 5, highlighting the recent activities of the Agency and in the Member States, on nuclear desalination was published and distributed at the General Conference. The nominations from the Member States for INDAG members for the third term (2005-08) were received and the members were designated by the Agency. The next INDAG meeting is planned for February 2006.

Progress reports from the CSIs in the framework of the CRP on **Economic research on, and assessment of, selected nuclear desalination projects and case studies** received from the CSIs were reviewed for inclusion in the proposed TECDOC. The beta version of DEEP 3.0 was released and sent to the CSIs and experts for validation.

The second expert mission for the TC National Project (2005-06 cycle) of Indonesia is planned for November 28-30, 2005 at Madura Island, Indonesia. Workshop on **nuclear reactors and desalination systems** for the UAE project is now planned for the first quarter of 2006.

A Session on **New energy-Nuclear** was held at the **IDA World Congress on Desalination and Water Reuse** during September 11-16, 2005 at Singapore. Two papers entitled **Status and Prospects of Nuclear Desalination** and **Recent Model Development for the Desalination Economic Evaluation Program (DEEP)** were presented at the Congress. A consultancy meeting on **Socio-economic and Environmental Aspects of Nuclear Desalination** was also held on the sidelines of the Congress.

The Agency was a co-sponsor of the **WSTA 7th Gulf Water Conference** held at Kuwait on November 19-23, 2005 with a keynote speaker on **Seawater Desalination using Nuclear Energy**.

The next Technical Meeting on **Integrated Nuclear Desalination Systems** is planned for December 2005 at Vienna. Issues related to the state-of-art of deployment of integrated nuclear desalination system including the techno-economic and socio-environmental aspects of nuclear desalination is to be discussed during the meeting. Contact: B.Misra@iaea.org.

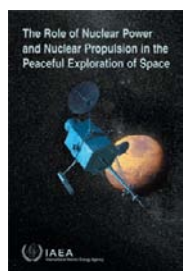
Recent Publications



Human performance improvement in organizations: Potential application for the nuclear industry

IAEA TECDOC Series No. 1479

This document is primarily for managers and specialists in nuclear facility operating organizations working in the area of human performance improvement. It is intended to provide them with practical information they can use to improve human performance in their organizations. While some of the information provided in this document is based upon the experience of nuclear facility operating organizations, most of it comes from human performance improvement initiatives in non-nuclear organizations and industries. The nuclear industry has a long tradition of sharing good management practices in order to foster continuous improvement. However, it is not always realized that many of the practices that are now well established initially came from non-nuclear industries and were adapted for application to nuclear power plant operating organizations. There is, therefore, good reason to periodically review non-nuclear industry practices for ideas that might have direct or indirect application to the nuclear industry in order to potentially gain benefits such as the following: new approaches to certain problem areas, insights into new or impending challenges, improvements in existing practices, benchmarking of opportunities, development of learning organizations, avoidance of collective blind spots.



The Role of Nuclear Power and Nuclear Propulsion in the Peaceful Exploration of Space

This publication provides details of a variety of radioisotope power systems, shows in what circumstances they surpass other power systems, and provides the history of the space missions in which they have been employed. The book also summarizes the use of on-board reactors and the testing done on reactor rocket thrusters as well as provides a review of current technology, a consideration of future applications, and a bibliography of further information on space nuclear technology. This publication also attempts to identify those R&D areas where space related nuclear power systems can be of practical relevance to efforts in innovative

reactors and fuel cycle technology development that are currently being pursued within various international collaboration frameworks.

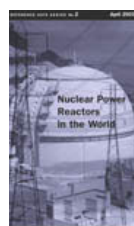


Optimization of the Coupling of Nuclear Reactors and Desalination Systems

IAEA TECDOC Series No. 1444

In 1998, the IAEA initiated a Coordinated Research Programmed (CRP) on "Optimization of the Coupling of Nuclear Reactors and Desalination

Systems" with participation of institutes from nine Member States in order to share relevant information, optimize resources and integrate related research and development in this area. All nuclear reactor types can provide the energy required by the various desalination processes. A total of nine nuclear reactors were examined for optimal coupling with desalination systems within this CRP. They are all of the water-cooled reactor type and are in various degrees of development. The commercial sea water desalination processes, which are proven and reliable for large scale production of desalted water are multi-stage flash (MSF) and multi-effect distillation (MED) for distillation processes and reverse osmosis (RO) for membrane processes and hybrid technologies such as MSF-RO and MED-RO. Different coupling options between the above nuclear and desalination technologies have been investigated within the CRP and were optimized with respect to safety, operational flexibility, reliability/availability and economics.



Nuclear Power Reactors in the World

Reference Data Series No. 2

This is the twenty-fourth 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 2004 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 Agency through designated national correspondents in the Member States. The replies are used to maintain the IAEA's Power Reactor Information System (PRIS).

Also available:

| Type | Title |
|------------------|--|
| IAEA-TRS-429 | Guidelines for Application of the Master Curve Approach to Reactor Pressure Vessel Integrity in Nuclear Power Plants |
| IAEA-TRS-428 | The Power Reactor Information System (PRIS) and its Extension to Non-electrical Applications, Decommissioning and Delayed Projects Information |
| IAEA-TECDOC-1435 | Application of Surveillance Programmed Results to Reactor Pressure Vessel Integrity Assessment |
| IAEA-TECDOC-1434 | Methodology for the assessment of innovative nuclear reactors and fuel cycles: report of Phase 1B (first part) of the International Project on Innovative Nuclear Reactors and Fuel Cycles (IN-PRO). |
| IAEA-TECDOC-1411 | Use of Control Room Simulators for Training of NPP Personnel |
| IAEA-TECDOC-1406 | Primary Coolant Pipe Rupture Event in Liquid Metal Cooled Reactors |
| IAEA-TECDOC-1405 | Operational and Decommissioning Experience with Fast Reactors |
| IAEA-TECDOC-1402 | Managing modernization of nuclear power plant instrumentation and control systems |
| IAEA-TECDOC-1400 | Improvement of In-Service Inspection in Nuclear Power Plants |
| IAEA-TECDOC-1399 | The Nuclear Power Industry's Ageing Workforce: Transfer of Knowledge to the Next Generation |
| IAEA-TECDOC-1395 | Intercomparison and Validation of Computer Codes for Thermohydraulic Safety Analysis of Heavy Water Reactors |
| IAEA-TECDOC-1393 | International Outage Coding System for Nuclear Power Plants |
| IAEA-TECDOC-1392 | Development of Instructors for Nuclear Power Plant Personnel Training |
| IAEA-TECDOC-1391 | Status of Advanced LWR Designs: 2004 |
| IAEA-TECDOC-1390 | Construction and Commissioning Experience of Evolutionary Water Cooled Nuclear Power Plants |
| IAEA-TECDOC-1389 | Managing Modernization of Control Systems |

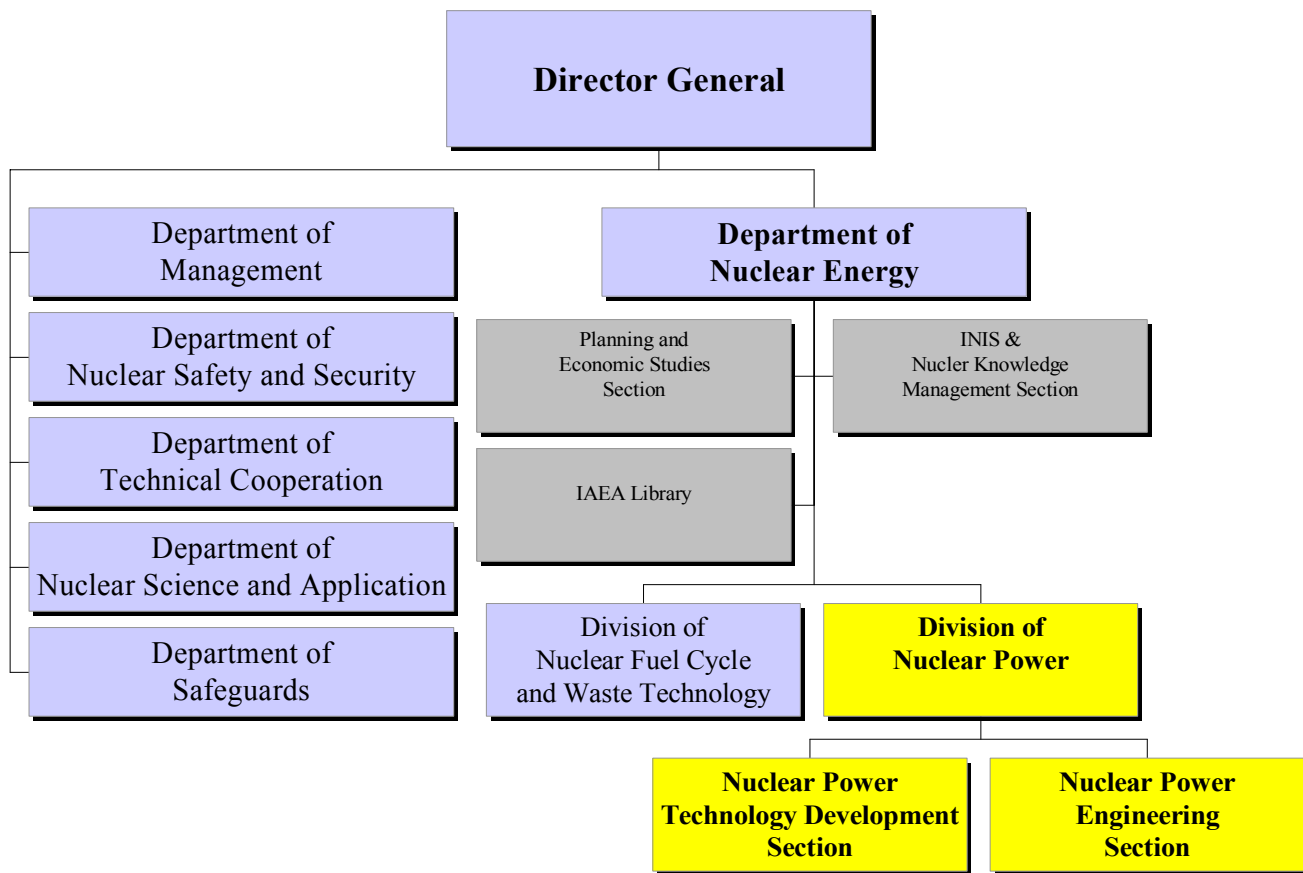
Planned Meetings in 2006

| Start Date | End Date | Meeting Title | Location | Country |
|------------|-----------|---|--------------|--------------|
| 06-Feb-06 | 08-Feb-06 | International Nuclear Desalination Advisory Group(INDAG) | VIC | Austria |
| 03-Apr-06 | 07-Apr-06 | TM/RCM on Updated Codes and Methods to Reduce the Computational Uncertainties of the LMFR Reactivity Effects | VIC | Austria |
| 04-Apr-06 | 06-Apr-06 | TM of the Technical Working Group on Training and Qualification of NPP Personnel | VIC | Austria |
| 18-Apr-06 | 28-Apr-06 | Training Course on Desalination System Modelling: Technology and Economics | ICTP Trieste | Italy |
| 15-May-06 | 19-May-06 | Regular Meeting of the TWG-FR | Beijing | China |
| 12-Jun-06 | 16-Jun-06 | TM on the Status of Verification and Testing of Passive Safety Systems for SMRs | VIC | Austria |
| 12-Jun-06 | 15-Jun-06 | TM to Foster Information Exchange on Socio-economic and Environmental Aspects of Nuclear Desalination | VIC | Austria |
| 19-Jun-06 | 22-Jun-06 | TM on Quality Management of NPP Personnel Training | VIC | Austria |
| 11-Sep-06 | 16-Sep-06 | RCM on Natural Circulation Phenomena, Modelling and Reliability of Passive Systems that Utilize Natural Circulation | Cadarache | France |
| 25-Sep-06 | 29-Sep-06 | RCM on Evaluation of High Temperature Gas Cooled Reactor Performance | Pretoria | South Africa |
| 09-Oct-06 | 12-Oct-06 | TM to Disseminate Good Practices on the Training for the Commissioning of Nuclear Power Plants | VIC | Austria |
| 09-Oct-06 | 12-Oct-06 | Economic research on, and assessment of, selected nuclear desalination projects and case studies | VIC | Austria |
| 11-Oct-06 | 13-Oct-06 | RCM on Master Curve Approach to Monitor the Fracture Toughness of Reactor Pressure Vessel in NPPs | Dresden | Germany |
| 16-Oct-06 | 20-Oct-06 | TM to Review the Enabling Technologies for SMRs | VIC | Austria |
| 04-Dec-06 | 08-Dec-06 | TM on Development of Benchmarking Processes for Economic PI and O&M Costs | VIC | Austria |
| TBD | TBD | TM on Constructive Relationship Between All the NPP stakeholders: Regulatory, Utility and Supplier Organizations | VIC | Austria |
| TBD | TBD | TM on Lessons Learned from Large Modernization Projects in I&C Systems | TBD | TBD |
| TBD | TBD | TM on Cyber Security Applications in Reactor Protection I&C Systems | TBD | TBD |
| TBD | TBD | TM on Increasing Power Output and Performance of NPPs by Improved I&C Systems | TBD | TBD |
| TBD | TBD | TM on Decommissioning Review Guidelines | VIC | Austria |
| TBD | TBD | TM to Organize the 2nd International Conference on Nuclear Plant Life Management | VIC | Austria |
| TBD | TBD | TM on Maintaining and Operating the PRIS Database and its Products: Module 1, 2 and 3 | VIC | Austria |
| TBD | TBD | TM on Resolution of Comments of the Safety Standard Committee | VIC | Austria |

| Start Date | End Date | Meeting Title | Location | Country |
|------------|----------|---|------------|---------|
| TBD | TBD | TM on Management Systems | TBD | TBD |
| TBD | TBD | TM on the Preparation of Country Profiles on Innovative Technology Developments | VIC | Austria |
| TBD | TBD | TM on the INPRO Methodology in the Area of Environment for the Assessment of Non-nuclear Energy Sources | VIC | Austria |
| TBD | TBD | TM on the Adaption of the Life Cycle Assessment (LCA) and Material Flow Assessment (MFA) Techniques to the Specific Requirements of INPRO | VIC | Austria |
| TBD | TBD | TM on the Development of Recommendations for Infrastructure Changes to Support the Deployment of INS | VIC | Austria |
| TBD | TBD | TM on the Update of the User Manual for INPRO Methodology | VIC | Austria |
| TBD | TBD | TM on Further Development of Proliferation Resistance Assessment | VIC | Austria |
| TBD | TBD | 10th INPRO Steering Committee Meeting | VIC | Austria |
| TBD | TBD | TM to Identify the Exact Scope of Activities for INPRO Phase-II | VIC | Austria |
| TBD | TBD | 9th Steering Committee Meeting on Innovative Nuclear Reactors and Fuel Cycles (INPRO) | VIC | Austria |
| TBD | TBD | TM on Comparison of Simulation Results for Severe Transients in Heavy Water Reactors | VIC or CAN | |
| TBD | TBD | TM on the Review of the Status of Accelerator Driven Systems R&D and Technology | VIC | Austria |
| TBD | TBD | TM on Fuel Failure and Failed Fuel Detection Systems for Fast Reactors | Kalpakkam | India |
| TBD | TBD | TM on the Comparative Assessment of the Dynamics and Safety Characteristics of Transmutation Systems | TBD | TBD |
| TBD | TBD | TM on the Review of the Status of Fast Reactor R&D and Technology | VIC | Austria |
| TBD | TBD | TM on the Implementation of Fast Reactor Data Retrieval and Knowledge Preservation Activities | VIC | Austria |
| TBD | TBD | TM of the Group of Deep Users | VIC | Austria |
| TBD | TBD | TM to Organize an International Symposium on Non-electric Applications of Nuclear Power in 2007 | TBD | TBD |
| TBD | TBD | TM on Integrated Nuclear Desalination Systems | TBD | TBD |
| TBD | TBD | TM on Design and Safety Approaches for Coupling of Hydrogen Production Systems with Nuclear Reactors | VIC | Austria |
| TBD | TBD | TM to Prepare the International Symposium on Non-electric Applications of Nuclear Power in 2007 | VIC | Austria |
| TBD | TBD | Advisory Meeting with Nuclear Hydrogen Experts | VIC | Austria |

Division of Nuclear Power Web Site Links

Division Introduction : NENP home: <http://www.iaea.org/OurWork/ST/NE/NENP/index.html>



Nuclear Power Engineering Section (NPES)

<http://www.iaea.org/OurWork/ST/NE/NENP/NPES/index.html>

- Main activities and result
<http://www.iaea.org/OurWork/ST/NE/NENP/NPES/Activity/index.html>
- Publications and documents
<http://www.iaea.org/OurWork/ST/NE/NENP/NPES/publications.html>
- Contact persons
<http://www.iaea.org/OurWork/ST/NE/NENP/NPES/staff.html>
- Databases (PRIS, CNPP, ENTRAC), software (SAT) and downloads
<http://www.iaea.org/OurWork/ST/NE/NENP/NPES/Downloads/index.html>

Nuclear Power Technology Development Section (NPTDS)

<http://www.iaea.org/OurWork/ST/NE/NENP/NPTDS/Projects/index.html>

- Databases and software
 - ▶ Fast Reactors Database:
<http://www-frdb.iaea.org/index.html>
 - ▶ ADS Database:
<http://www-adsdb.iaea.org/index.cfm>
 - ▶ User friendly education with nuclear reactor simulators
<http://www.iaea.org/OurWork/ST/NE/NENP/NPTDS/Projects/edu.html>
- Active Coordinated Research Projects (CRPs)
<http://www.iaea.org/OurWork/ST/NE/NENP/NPTDS/crps.html>



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