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Nuclear Power Newsletter

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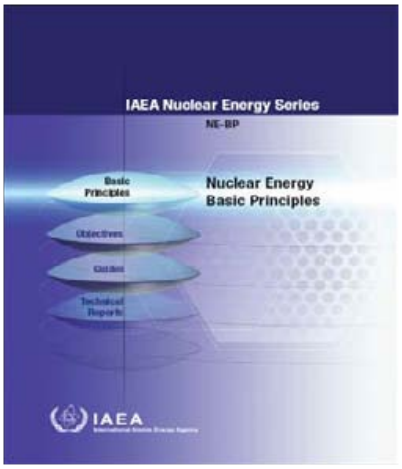
Division of Nuclear Power
Department of Nuclear Energy
IAEA

P.O. Box 100
Wagramer Strasse 5,
A-1400 Vienna, Austria
Tel : +43 1 2600 22751
Fax: +43 1 2600 29598
Email: *I.Khamis@iaea.org*.

IAEA Nuclear Energy Series Introduces its Top Level Publication



IAEA's *Nuclear Energy Basic Principles*, the foundation of the Nuclear Energy Series, is now available. Important to all Member States interested in nuclear energy, this new publication presents the eight basic principles on which nuclear energy systems should be based to fulfill nuclear energy's potential to help meet growing energy needs.

Read more on page 2

IAEA Introduces a New Peer Review Service

The Integrated Nuclear Infrastructure Review (INIR) mission, a new IAEA-coordinated peer review service, is a holistic programme to assist a Member State in determining its infrastructure development status. INIR missions are conducted by a team of international experts and led by an IAEA staff member.

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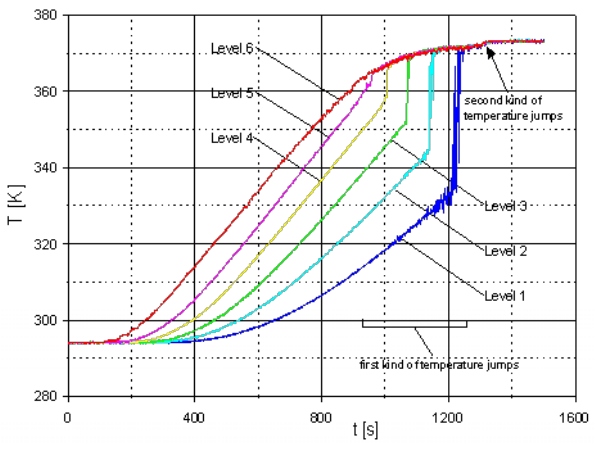
Natural Circulation Phenomena, Modelling, and Reliability of Passive Systems that Utilize Natural Circulation



IAEA Coordenated Research Programme (CRP) on Natural Circulation Phenomena, Modeling, and Reliability of Passive Systems that Utilize Natural Circulation has made remarkable achievements.

Read more on page 10

Message from the Director

Welcome to the March 2009 issue of NENP Newsletter

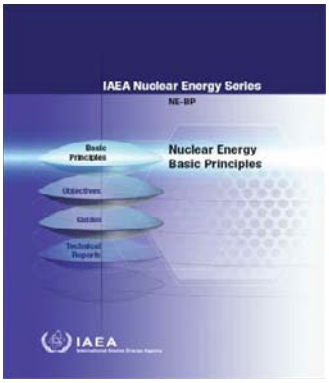
The Division of Nuclear Power has been publishing its newsletter since September 2004. With the departure in December 2008 of our editor-in-chief, Mr Sung-Kuk Cho, we welcome Mr. Ibrahim Khamis and a new editorial group consisting of several members of the Division, including myself. With this change in editorial staff, we are taking the opportunity to reassess how the Nuclear Power newsletter can better serve our audience. This first issue for 2009 changes direction in several respects. Our goals for improvement are to:

- Focus on new information in the spirit of an effective newsletter.
- Report results in more detail. Project outcomes, conclusions from meetings, and published new reports with supporting graphs, figures and tables will take precedence over articles on recently held meetings with group photographs.
- Present articles with sharper, more focused messages, reducing the overall volume of the newsletter.

This March issue follows our new editorial direction as much as possible. In addition, we have highlighted more information on forthcoming conferences, major meetings and symposia, although we do not cover all the meetings.

We hope that you find our new approach effective and we welcome and greatly appreciate your feedback.

IAEA Nuclear Energy Series Introduces its Top Level Publication



The Nuclear Energy Basic Principles, the leading publication within the IAEA Nuclear Energy Series. Available at http://www-pub.iaea.org/MTCD/publications/PDF/Pub1374_web.pdf

Important to all Member States interested in nuclear energy, this new publication presents the eight basic principles on which nuclear energy systems should be based to fulfill nuclear energy's potential to help meet growing energy needs: benefits, transparency, protection of people and the environment, security, non-proliferation, long term commitment, resource efficiency and continual improvement. These principles are intended to provide a holistic approach to the use of nuclear energy and to be equally applicable to all elements of nuclear energy systems, including human resources and technical, management and economic aspects.

Within the publication, an overview of the basic principles explains the beneficial, responsible and sustainable use of nuclear energy. In specific detail, all eight principles are clearly identified, described and related recommendations are provided for nuclear energy systems. For example, Principle 1, Benefits, states that "the use of nuclear energy should provide benefits that outweigh the associated costs and risks", outlines the different types of benefits, costs and risks associated with different energy systems (such as environmental, economic, and proliferation related) and recommends that these issues be carefully considered in developing an assessment. In addition to the discussion of basic principles, the publication includes an outline of the structure of the IAEA Nuclear Energy Series, helpful for identifying all of the covered topic areas.

Contact: *l.stern@iaea.org*; or *p.vincze@iaea.org*

All Nuclear Energy Series publications, along with a more detailed description of the series, can be found at: http://www.iaea.org/OurWork/ST/NE/NESeries/ClickableMap/ and http://www.iaea.org/OurWork/ST/NE/NESeries/nes_brochure2008.pdf

Instrumentation and Control System Technologies

Two new Nuclear Energy Series (NES) Reports on digital instrumentation and control (I&C) systems will be published soon. Both reports address critical issues in the design, implementation, licensing, and operation of digital I&C systems important to safety in nuclear power plants. The first report, *Implementing Digital I&C Systems in the Modernization of Nuclear Power Plants (NPPs)*, discusses the main points of projects aimed at modernizing I&C systems in existing NPPs by utilizing digital I&C technologies. The second report, *Protecting Against Common-Cause Failures in Digital I&C Systems*, addresses challenges posed by the introduction of computer-based technologies to safety systems, specifically, the common cause failures (CCF), their triggering and propagating mechanisms, assessment of susceptibility, and preventive measures. The latter includes solutions for defence in depth, diversity, redundancy, and independence.

Other reports are currently under development. The *Integration of Analog and Digital Instrumentation and Control Systems in Hybrid Control Rooms* will assist nuclear utilities plan control room and other human-machine interface (HSI) changes that make appropriate use of modern technologies which manage aging and obsolescence, and facilitate improvements to plant performance and safety. The report covers a broad spectrum of potential changes to the control room, ranging from the replacement of a few obsolete components with newer digital devices, up to a fully computerized control room.

Another report, *Core knowledge on I&C systems in NPPs*, is a unifying reference document which will place existing I&C-related IAEA and non-IAEA technical documents within the context of a global view of NPP I&C systems and their lifecycles. This report's development was driven by a need to have an introductory description and to present a basic understanding of I&C systems and functions in NPPs. It provides a useful summary, while also presenting a concise overview for use as reference by more experienced I&C engineers. In addition, the importance of I&C systems is emphasized in almost all aspects of the safe and economical operation of NPPs by referencing the appropriate IAEA technical documents and other reports that address these issues.

For those interested in a more interactive forum on these issues, an upcoming workshop, *Impact of Digital I&C on the Operation and Licensing of Nuclear Power Plants*, will be held on 4-8 May 2009 in Portoroz, Slovenia, under the IAEA Technical Cooperation Project RER/4/030: Strengthening Capabilities for Nuclear Power Plant Performance and Service Life Including Engineering Aspects. This workshop will provide an international forum for presentations and discussions on the impact of digital technologies on the operation, testing, maintenance, and licensing of new and modernized I&C systems. Presentations will cover relevant I&C and HSI issues in operating NPPs and in new designs. Lessons learned from completed or planned digital I&C upgrading projects will be presented and discussed. The workshop is intended for staff from nuclear power utilities, vendor companies, licensing bodies, research organizations and academic institutions. For more information please visit:

http://www.iaea.org/NuclearPower/IandC/

or contact O.*Glockler@iaea.org*.

Human Resource Management

Training and Development for Nuclear Power Plant Managers

Competence of nuclear power plant managers is a crucial issue for any phase of a nuclear power plant (NPP) life cycle, in particular, for the safe and efficient operation. The IAEA, and its Division of Nuclear Power, pay close attention to development of NPP managers' competence through its publications, training courses and workshops, and technical cooperation activities. For example, the IAEA's *Selection, Competency Development and Assessment of Nuclear Power Plant Managers' (IAEA-TECDOC–1024)* is widely used by Member States; and the Division of Nuclear Power in cooperation with other IAEA units regularly performs training courses and workshops for nuclear power industry managers. In addition, technical cooperation activities include projects to train and develop managers for various phases of the NPP life cycle. A consultant's meeting was held at IAEA Headquarters in December 2008 to obtain advice from nuclear power senior managers on needs in the development of NPP managers and on proactive ways that the IAEA can assist in developing the competence of NPP management staff. NPP managers from seven countries (Canada, Finland, Hungary, Romania, Russian Federation, Ukraine and the United Kingdom) participated. The involvement and advice of NPP senior managers provided important first-hand knowledge to the IAEA on stakeholders' needs and gave industry professionals an excellent opportunity to network and share experiences.

Contact: *A.Kazennov@iaea.org*

Supporting countries planning to expand nuclear power programmes

The IAEA TC project ARM0005: Feasibility of nuclear energy option in Armenia: Identification of human resource development needs in conjunction with new NPP build was successfully completed. A project report highlighting specific human resource development needs in Armenia in conjunction with possible build of NPPs of selected types was prepared in Russian and provided to the counterpart, to his full satisfaction. There are plans to translate this report into English and publish it as an IAEA-TECDOC in 2009.

Contact: *v.v.kuznetsov@iaea.org*

Nuclear Power Plant Life Management for Long Term Operation

Review Mission on the Ageing Management Programme Held at Paks Nuclear Power Plant

Upon an invitation from the Hungarian Atomic Energy Agency (HAEA), the IAEA conducted a peer review mission at the Paks Nuclear Power Plant, Hungary during November 2008. The objective of the service was to review the Mechanical Components Ageing Management Programme (AMP) based on related IAEA Safety Standards and guidance documents, and internationally accepted practices. Prior to the mission, the Paks NPP had already submitted their Program of Long Term Operation to the HAEA. The evaluation reports on Mechanical Components AMP in the Paks NPP were divided into two groups:

1) Degradation mechanism driven AMPs.
2) Component-specific AMPs – the scope can be divided into two subgroups: (1) AMPs dealing with the separately managed major components, and (2) AMPs representing commodity groups of components. Currently, there are many AMPs already developed by the Paks NPP. The entire set of AMPs, which represents approximately 250 particular AMPs, will be completed in 2009.
Contact: *L.Kupca@iaea.org*

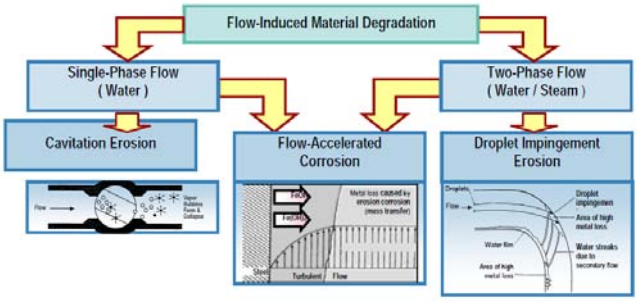
Detection, Research, Management and Monitoring of Ageing Factors in Nuclear Power Plants

In December 2008, participants attending the Regional Latin America (RLA) TC project workshop in Buenos Aires, Argentina had the opportunity to share recent knowledge and experience relating to material degradation issues and to discuss results from research programmes experiences and practices , and regulatory aspects from different countries. A total of 38 participants from Mexico, Brazil and Argentina participated in the workshop and 4 experts from Germany, Republic of Korea and the USA were invited and presented material on erosion and corrosion issues. The key findings through a regional workshop are:

- Equipment and material problems and anomalies must be rigorously addressed in a thorough and timely manner,
- Minimal compliance with regulatory standards is unacceptable,
- Need to have better material management and process improvement program,
- Get information through active involvement in several international projects/groups on ageing management (IAEA, OECD/NEA, EC),
- Need to have an Independent quality assurance organization.

All presentation materials and information from the workshop are available on the IAEA's website:

http://www.iaea.org/NuclearPower/PLIM- LTO/plim_TC_CAEA_December2008.html

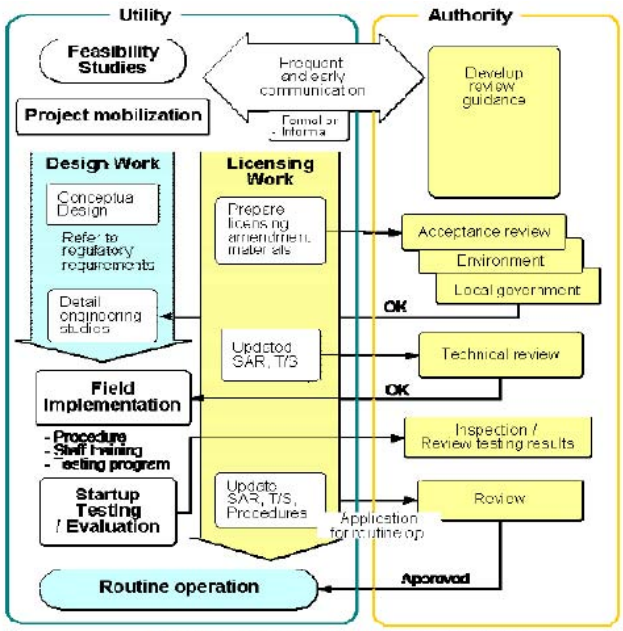


Flow-induced material degradation

Contact: *Ki-Sig.Kang@iaea.org*

Power Uprating in Nuclear Power Plants

The November 2008 meeting on power uprating (PU) discussed the development of a technical report which will provide information on current trends, licensing aspects, monitoring, verification technology after power uprating and the associated side effects. Currently, many nuclear power plants (NPPs) are considering PU by utilizing existing plant capability or by modification to produce more electricity. Refurbishment of plant components in plant life management will be coordinated with power uprating for optimum investment to improve performance.



General process for power uprating

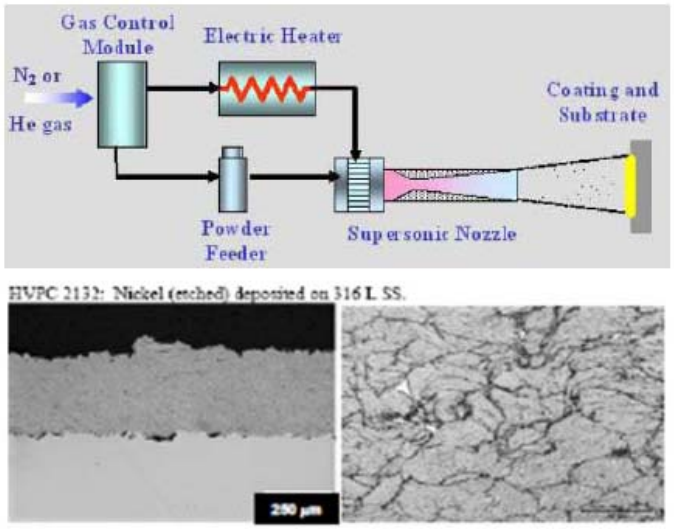
Contact: *Ki-Sig.Kang@iaea.org*

Good Practices to Manage Stress Corrosion Cracking of Austenitic Alloys in Light Water Reactors

The third consultancy meeting was held in January 2009 to finalize the extended technical report on Good Practices to Manage Stress Corrosion Cracking (SCC) of Austenitic Alloys in Light Water Reactors, with 13 experts from France, Germany, Japan, Rep. of Korea, Sweden, Switzerland, USA and OECD/NEA in attendance. The meeting's main objectives were to:

- Complete the mechanisms and major contributors of stress corrosion,
- Finalize the operational experience and feedback for PWRs and BWRs,
- Review the proposed draft on assessment and flaw analysis, mitigation and repair methods,
- Complete international/national research activities to manage SCC.

The completed technical report will provide descriptions of damage mechanisms of different types of SCC with regard to systems, structures and components (SSCs) in light water reactors and information on good practices in preventing, mitigating and repairing SCC damages as well as information on related international/national R&D programmes. To minimize cold work and high levels of hardness and residual stress, the limiting cutting speeds using specific high speed steel tool, the polishing tool and process are introduced in the report. Practical operational experience and practices in Member States will also be presented. The report will be published in 2009.



Cold Spray Corrosion Resistant Coating Process

Performance Improvement through Benchmarking

The objective of benchmarking is to provide goals for realistic process improvement and an understanding of the changes necessary to facilitate that improvement. Comparing a utility's own performance with others can identify gaps in performance and world-class performance leaders. Application of effective benchmarking improves safety performance and competitiveness of the organization.

Benchmarking requires a comprehensive and reliable source of internationally shared data. The IAEA Power Reactor Information System (PRIS) provides an effective tool for plant performance analyses. Possibilities and limitations of PRIS outputs in Nuclear Power Plant performance benchmarking were discussed at the consultancy meeting held in December 2008 at the IAEA Headquarters in Vienna.

The consultants emphasized that performance indicator comparison is just one step in benchmarking and only helps in identification of best performers. The next steps contain identification and implementation of processes which result in good performance. These steps require direct communication with identified best performers.

The PRIS data model is limited to the power reactor operational performance. The key areas where the PRIS data model can be utilize for benchmarking are:

- Electricity production,
- Plant availability - readiness to supply electricity to the grid,
- Unit capability - readiness to be operated at the expected power,

- Optimization of maintenance programs and outage management,
- System availability/reliability,
- External limitations - related to causes beyond plant management control,
- Transients during operation,
- Power uprating.

During the meeting, participants also focused on the question of what additional data elements should be collected for more comprehensive benchmarking. In addition, they discussed that benchmarking across several branches (not just nuclear) is possible and very useful but required harmonized assumptions and data definitions with other organizations.

Contact: Jiri Mandula *j.mandula@iaea.org*

Management Systems

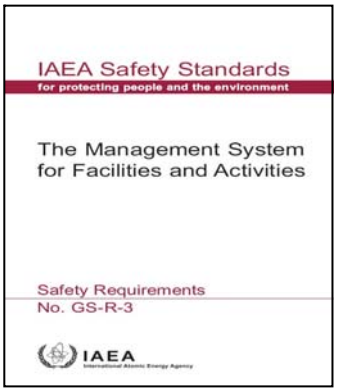
New Project Compares Management System Standards

Recently, a new project was initiated jointly with the American Nuclear Society Nuclear Quality Assurance (ASME) NQA-1 committee to prepare a document that would compare the requirements of the IAEA Safety Standards No. GS-R-3 publication with those of the latest issue of the ASME International's technical standard NQA-1-2008, Quality Assurance Requirements for Nuclear Facility Applications, to identify the similarities and main differences in concepts and detailed requirements. This report will provide information and guidance to users of GS-R-3 on the added safety-specific management system requirements that may be needed when NQA-1 is used by the nuclear industry. Likewise, users of NQA-1 can apply the guidance to understand any actions necessary when GS-R-3 is the basis used for a management system.

The IAEA Safety Standards Series No. GS-R-3 publication defines the requirements for establishing, implementing, assessing and continually improving a management system that integrates safety, health, environmental, security, quality and economic elements. The GS-R-3 requirements help those responsible for the management system foster a strong safety culture and improve safety performance. Organizations using GS-R-3 must often use other standards in their interfaces with suppliers and other stakeholders. In the USA and other countries applying US nuclear technology (e.g. Slovenia, Spain, China, Republic of Korea, and countries in south America) or supplying safety items and services to US nuclear facilities, NQA-1 is typically used for their (quality) management systems at the nuclear facility and supplier interface.

Therefore, it is important to assist these facilities with identification of safety requirements on management systems. NQA-1 is also typically used to comply with US nuclear safety regulations for quality assurance programs. A similar comparison was done between GS-R-3 and ISO9001:2000. The results of that comparison will serve as a guide.

This new comparison publication, Management System Standards: Comparison of IAEA GS-R-3 safety requirements and ASME NQA 1 quality assurance requirements, is intended for all parties involved in the nuclear industry such as regulators, owners, managers, operators, and employees of nuclear facilities; supplier, laboratory, medical, research, construction and engineering organizations, as well as other organizations applying NQA-1 as a basic management standard. It is expected to be released at the end of 2009.



Contact: *p.vincze@iaea.org*

Strengthening Nuclear Power Infrastructure

IAEA Introduces a New Peer Review Service

The Integrated Nuclear Infrastructure Review (INIR) mission, a new IAEA-coordinated peer review service, is a holistic programme to assist a Member State in determining its infrastructure development status. INIR missions are conducted by a team of international experts and led by an IAEA staff member.

Member States are encouraged to perform a self-evaluation prior to requesting an INIR mission. The INIR mission is intended to build upon a self-evaluation and provide guidance in areas where further work would be beneficial. It is not intended to be an external critical audit.

The INIR review is mainly based upon the approach presented in Nuclear Energy Series (NES) publications,

Milestones in the Development of a National Infrastructure for Nuclear Power (NG-G-3.1) and *Evaluation of the Status of National Nuclear Infrastructure Development* (NG-T-3.2). The mission scope can be adjusted to take into account the level of development (Phase 1 or 2) of a country.

The meetings and discussions that take place during INIR missions can also provide feedback on the effective implementation of IAEA Technical Cooperation (TC) assistance. While INIR missions can be requested at any time during the development of the nuclear infrastructure, they are typically expected to be arranged in the following sequence:

- Initial mission – to look at the overall situation in a country regarding the 19 infrastructure issues described in Milestones,
- Follow-up missions – as part of a continuous process of evaluation during the infrastructure development, focusing on fulfillment of past recommendations and suggestions,
- Before invitation of bids – to demonstrate readiness through a comprehensive external evaluation.

Achieving Milestone 2 is a key stage at which the Member State needs to demonstrate that it is "ready to invite bids for the first NPP". By demonstrating that the Member State has fulfilled the infrastructure development expectations set by IAEA guidance, it strengthens the national justification that the Member State is ready and fully prepared for commercial discussions.

Contact: T.Mazour@iaea.org and n.pieroni@iaea.org

Workshop on Evaluation Methodology Launches New Infrastructure Peer Review Service

The Integrated Nuclear Infrastructure Review (INIR) mission was introduced at the Workshop on Evaluation Methodology for Nuclear Power Infrastructure Development, held in Vienna in December 2008. Guidelines for conducting INIR missions in the infrastructure Phases 1 and 2 were developed with the assistance of a consultancy meeting immediately following the workshop. The guidelines are expected to be issued in early 2009. (Please refer to above article for more details on INIR missions).

Another area covered by the Workshop was the supplier perspective on infrastructure readiness of newcomers. Suppliers indicated that they take into account all infrastructure issues before deciding to respond to a bid invitation.

The Workshop also introduced a draft Nuclear Energy Series Technical Report on Responsibilities and Competencies of the Nuclear Energy Programme Implementing Organization (NEPIO) for a National Nuclear Power Programme. The concept of a NEPIO's function is to coordinate and integrate various stakeholders into the infrastructure planning process.

Assistance for infrastructure development in phases 1 and 2 is available through the Agency's Technical Cooperation programme, as well as through bilateral Government-to-Government assistance or use of private consultants. Workshop participants discussed the value of coordination among infrastructure assistance providers in a recipient country to improve efficiency. The IAEA is considering how appropriate coordination can be achieved.

Contact: a.starz@iaea.org

Initiating a Nuclear Power Programme on Responsibilities and Capabilities of the Owner/Operator

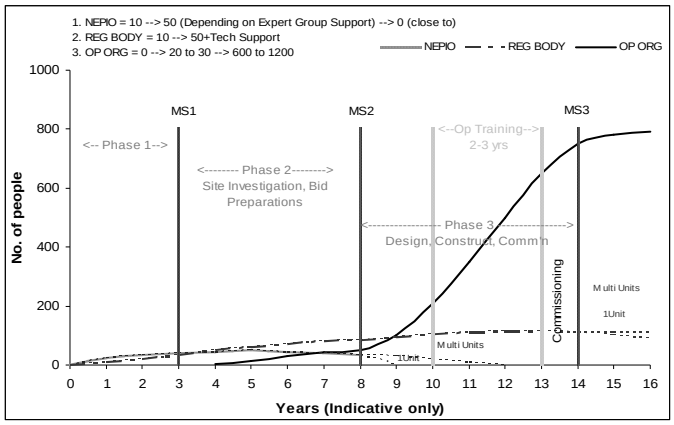
In January 2009, a consultancy meeting was held to finalize the Nuclear Energy Series (NES) draft document on *Initiating a Nuclear Power Programme - Responsibilities and Capabilities of the Owner/Operator*. The introduction of nuclear power opens new challenges to Member States including establishing an owner/operator organization that clearly understands its functions and responsibilities, and establishes appropriate interactions with the programme's partners and supporters. This NES report describes the main activities, desirable attributes, key responsibilities and main interfaces of the owner/operator during the preparation, construction and commissioning periods of a nuclear power project. During the meeting, a questionnaire on how to build the capabilities of an owner/operator was also developed. Responses to these questionnaires will be used to develop case studies that will be provided as appendices in the report. This publication is expected to be available in the first half of 2009.

Contact: x.li@iaea.org

Workforce Planning For New Nuclear Power Programmes

Human resource development is recognized as a key aspect regarding the introduction of nuclear power programmes. All of the IAEA TC Projects supporting newcomers in introducing nuclear power include a component related to human resource development, including education and training. As a complement to the support provided through these TC projects, the IAEA is developing a Nuclear Energy Series publication on workforce planning for new nuclear power programmes. A second draft of this publication will be reviewed at a Technical Meeting at IAEA Headquarters from 31 March – 2 April. This meeting will also provide a forum for information exchange among decision makers, advisers and senior managers in the governmental organizations, utilities, industry, and regulatory bodies of a country with an interest in developing nuclear power. This publication will also be of particular interest to national, and international, educational and training establishments, and research and technical support organizations, which may be called upon to assist in developing the national infrastructure.

The figure below, included in the draft document, provides an example of the human resources typically needed during the first phases of a nuclear power programme. It should be recognized that these numbers will vary depending upon a variety of factors including those related to technology, and national norms. This figure does not address the competencies needed by these individuals. The description of these competencies is a major aspect of this draft document.



Typical HR needs for an NPP Project

Contact: *T.Mazour@iaea.org*

International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)

PRADA and a systematic approach of Acquisition/ Diversion Pathway Analysis

The Proliferation Resistance: Acquisition/Diversion Pathway Analysis (PRADA) is one of INPRO Collaborative Projects and proposed by the Republic of Korea. The objectives of PRADA are to identify and analyze high-level pathways for the acquisition of weapons usable material using an innovative nuclear system case study; and make recommendations for evaluating multiplicity and robustness of barriers against proliferation. PRADA is based on a case study on the DUPIC fuel cycle conducted by the Republic of Korea. In November 2008, PRADA held its third meeting to discuss a draft progress report.

Discussion at the meeting was extensively on: the threat analysis/definition (host State capabilities, objectives and strategy for proliferation), a systematic approach of pathway analysis, and the structure of the pathway analysis worksheet. Agreed systematic approach shall be used as the basic guideline for performing the PRADA analysis.

About **PRADA**: http://www.iaea.org/INPRO/prada.html

Contact: *H.Chayama@iaea.org*

Global Scenarios and Regional Trends of Nuclear Energy Development in the 21st Century

A study on Global Scenarios and Regional Trends of Nuclear Energy Development in the 21st Century was started in 2009. A holistic evaluation of possible options for nuclear energy on a global and regional scale over several decades will be performed by simulation modeling.

The main task of the study is to analyze possible development of Innovative Nuclear Energy Systems (INS) and its impact on sustainable energy supply taking into account present directions of the development of different regions of the world. In course of the study by June 2009 a document will be prepared, which will present:

- Analysis in a generalized manner of possible development of INS and its impact on sustainable energy supply taking into account present directions of the development of different regions of the world;

- Broad matrix framework for INS adequate to provide the Nuclear Energy (NE) growth rates related to sustainability challenges;
- Indication of necessary R&D and institutional framework to be explored in further details in order to achieve required innovations for possible deployment of INS in the future.

Eight regions to represent the geographical cut of NE development in the world have been set. The study will also illustrate multi-regional nuclear energy system strategies for three chosen scenarios (table below).

Chosen three scenarios for the Study on Global Scenarios and Regional Trends of Nuclear Energy Development in the 21st Century, installed capacity, GW(e)

Year	Low	Moderate	High
2030	500	600	700
2050	1000	1500	2000
2100	2500	5000	10000

The second meeting to review the draft of the document and to formulate findings and conclusions from this study is planned for early May 2009.

Contact: M.Khoroshev@iaea.org

Legal and Institutional Issues of Transportable Nuclear Installations

A growing number of developing countries have indicated an interest in exploring nuclear power to meet their energy demands. Countries are evaluating the use of non-conventional approaches for niche applications, especially for areas with limited infrastructure or for non electric applications. Some countries with small electrical grids, remote and difficult-to-access areas, or with many isolated islands are interested in the use of Transportable Nuclear Installations (TNI) (small transportable NPPs). These TNIs may have unique features such as: factory assembly with the reactor units to be delivered already assembled to the site; barge mounted NPPs; reactors without on-site refueling such as nuclear batteries with all fuel handling/management operations being outsourced to the specialized factory or to a vendor.

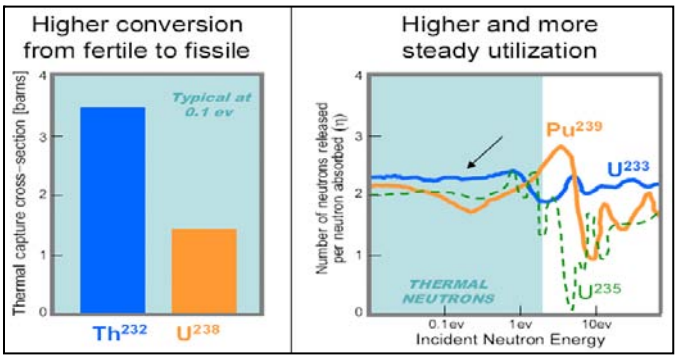
A study on Legal and Institutional Issues of Transportable Nuclear Installations (TNIs) has been launched at a kick-off meeting in October 2008. The objectives of the study are to investigate legal and institutional issues, identify possible benefits and challenges for deployment of TNIs, taking into account economic and technical aspects using various deployment schemes; and to propose solutions and make recommendations to address the identified challenges.

The scope of the study includes: licensing, insurance, guarantees for nuclear fuel supply, transportation, monitoring and control, economic schemes/mechanisms, security, register the unique accountable threats, physical protection, nuclear materials accounting and control, legal support, smoothing out barriers in the legislation of participating countries, rules for announcing and providing services, international standardization and certification, testing centres and human resources. The study does not refer to any particular design or reactor size and is independent of the contracting options (such as Build-Own-Operate (BOO), Build-Own-Operate-Transfer (BOOT), annual contract for electricity, lifetime contracts). A meeting to review the draft document will be held in March 2009.

Contact: M.Khoroshev@iaea.org

Thorium: Essential Part of the Future

The large use of thorium to support a large-scale deployment of nuclear energy systems in the future is being explored under INPRO in a Collaborative Project on Further Investigation of Thorium Fuel Cycles. In the collaborative project, the participating Member States are: The European Commission, India, Canada, Slovakia, Russian Federation, China and Republic of Korea. In January 2009, a next step was made in a consultancy meeting. Among others, a number of Thorium-based fuel cycle options have been identified for consideration by INPRO. In addition to the participating members of the collaborative projects, several observers from Thorium Power (USA), Thor Energy (Norway) and the Institute of Energy Research at Juelich (Germany) participated in the meeting.



Thorium performance in thermal reactors in comparison to Plutonium

The creation and utilization of fissile material in the thorium-based fuel cycles is feasible without the need to use fast reactors nor reprocessing of spent fuel. This is because fissile material U233 from naturally occurring Th232 and its use (fission) in a recycling fashion (near

breeding) can be done in thermal spectrum. This is illustrated in the figure above.

Among these, the following three groups of several fuel cycle options suitable for short-term to mid-term applications were identified at the consultancy meeting: 1) Once-through uranium/thorium fuel cycle in HWR, PWR, BWR and HTGR. This include the conventional once-through ,fuel-reshuffling and recycling of mechanical-reconfigured fuel; 2) Once-through plutonium/thorium fuel cycle in HWR, PWR, BWR and HTGR. This is similar to the first option except existing Pu239, instead of U235, is used to start the fission process prior to sufficient creation of U233 in the reactor core A special variation of this are designs for the purpose of reducing the plutonium as potential weapon material; and 3) Synergism between fast reactor (FR) and thermal reactors, in which a number of FRs are specially operated as factories of converting thorium into U233 to feed several times number of PWR, BWR, HWR or HTGR.

Contact: *R. Sollychin@iaea.org*

Technology Development for Water Cooled Reactors

Nuclear Power Plant Technology Assessment

More than 50 experts from 35 countries participated in the annual workshop on Steps for Conducting Nuclear Power Plant Technology Assessments, held in Vienna from 17 to 20 November 2008. The goal of the workshop was to provide Member States with the technical expertise and a systematic approach on how to evaluate the technical merits of the various nuclear technologies available on the market, hence allowing them to select what better fits their specific needs and requirements. The workshop also addressed general concerns and needs of Member States during the planning phase of initiating and/or expanding a nuclear power programme.

Participants of the workshop exchanged information on planning and conducting technology assessments of nuclear plant designs, with a focus on water-cooled reactor technology. The majority of the participants reported that the new information provided during the workshop was beneficial and relevant to their country's situation, and recommended some enhancements for future editions of the workshop such as increasing the number and the diversity of the case studies presented during the workshop to better utilize the experience available from various countries and nuclear operators.

The future IAEA report on Technology Assessment, which will be a comprehensive practical guideline for

conducting a systematic technology assessment, will incorporate the insights provided by experts from more than 35 countries, practical examples and case studies, as well as the feedback and suggestions provided by the workshop participants.

For more information on Technology Assessment and the 2008 workshop, please visit*:* http://www.iaea.org/NuclearPower/Technology/Assessment/WS2008.html

Contact: S. Bilbao y León (*S.Bilbao@iaea.org*)

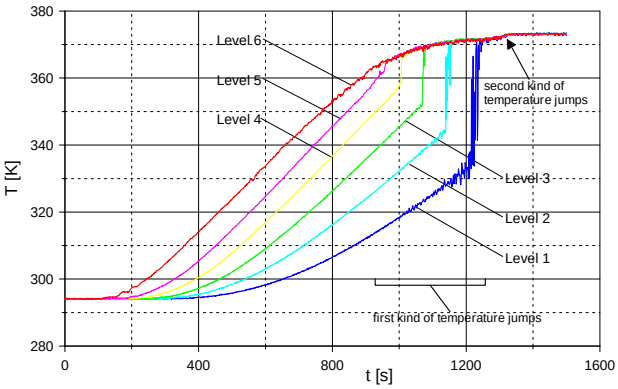
Natural Circulation Phenomena, Modeling, and Reliability of Passive Systems that Utilize Natural Circulation

After four years of research, the IAEA CRP on Natural Circulation Phenomena, Modeling, and Reliability of Passive Systems that Utilize Natural Circulation has made remarkable achievements in the following areas:

- Establishment of the status of knowledge: passive system initiation & operation; flow stability, 3-D effects and scaling laws,
- Investigation of the phenomena which influences the reliability of passive natural circulation systems,
- Review of experimental data base on natural circulation phenomena,
- Evaluation of computer code's ability to predict the natural circulation and related phenomena,
- Application of methodologies to examine the reliability of passive systems.

Twenty reference advanced reactor designs, including evolutionary and innovative designs, were selected to examine the use of natural circulation and passive systems in real nuclear power plants. Twelve phenomena that influence natural circulation were identified and characterized (Figure shows a temperature stratification phenomenon found from the study for behavior in large pools of liquid based on 6 levels of thermocouples along the wall of the heated tank. Level 1 is at the bottom and

Level 6 is at the top). A cross connection between passive system type and related thermal hydraulic phenomena was made for each passive safety system.



Formation and Destruction of Temperature Stratification in Wall Heated Tank

A comprehensive review of the CRP draft report and recommendation for improvement were made in the fourth research coordination meeting held on 3-6 November 2008 in Vienna.

Contact: *J.H.Choi@iaea.org*.

Technology Development for Small and Medium Sized Reactors

Small Reactors without On-site Refueling

In its final year with 16 research organizations from 9 member states participating**,** the CRP on Small Reactors without On-site Refueling. Upon an arrangement with the NEA OECD, several participants of the CRP from non-OECD countries participate in a benchmarking exercise for forced and natural circulation of lead-bismuth coolant based on the tests performed in the HELIOS loop at the Seoul National University (the Republic of Korea). HELIOS Phase I calculation results (two forced convection modes) submitted by the participants from the Agency participants were accepted by the OECD/NEA secretariat and are generally in reasonable agreement with all other results. The final research coordination meeting for the CRP Small Reactors without On-site Refueling has been convened on 3-6 November 2008, in Vienna. The scope and schedule for the preparation of a CRP report have been defined, and nearly 40% of the materials for this report have been submitted to the Agency. An updated Web page of the CRP is at: http://www.iaea.org/NuclearPower/SMR/CRP1/ .

Developing Methodologies to Assess Passive Safety System Performance in Advanced Reactors

With 8 participating research institutions from Argentina, France, India, Italy, the Russian Federation, and the USA, the IAEA has launched a new CRP on the Development of the Methodologies for the Assessment of Passive Safety System Performance in Advanced Reactors. The main objective is to determine a common analysis-and-test based method for reliability assessment of passive safety system performance. Such a method would facilitate application of risk-informed approaches in design optimization and safety qualification of the future advanced reactors, contributing to their enhanced safety levels and improved economics. The CRP is conducted in cooperation with the Technical Working Groups on Advanced Light Water Reactors and Fast Reactors of the Department of Nuclear Energy and the Safety Assessment Section of the IAEA's Department of Nuclear Safety and Security. The first research coordination meeting is scheduled for 31 March – 3 April 2009. Several new potential participants are considering an option to participate in the RCM as observers. More details on this CRP and application procedures is at: http://cra.iaea.org.

Assessing SMR Competitiveness

Full draft of the new Nuclear Energy Series Report on Approaches to Assess SMR Competitiveness has been prepared and submitted for review. The report is prepared to assist potential users in their assessment of economic and investment characteristics of SMRs and to provide a framework to assist potential stakeholders in the definition of a competitive strategy regarding design and deployment of SMRs in liberalized energy markets. Inter alia, the report presents a suite of methodologies approaches and methodologies, as available in member states and international organizations that could assist designers and guide potential users on making intelligent choices between different nuclear power options involving SMRs as well as large reactors. The report also suggests a consolidated approach bringing together all currently available state-of-the-art models for generation costs, revenues, financial costs, investments, and external factors and risks, while "keeping the door open" for any models once it becomes available. The report is prepared in cooperation with the IAEA's Planning and Economic Studies Section.

Technology Development for Gas Cooled Reactors

Year 2009 is expected to witness the eventual construction of a High Temperature Gas-Cooled Pebble-Bed type Reactor. First concrete for the Chinese High Temperature Reactor–Pebble-Bed Module (HTR-PM) is scheduled to take place in the second half of 2009. Last year, the US Department of Energy (DoE) issued a request for information and expressions of interest in the Next-Generation Nuclear Plant (NGNP) on an advanced reactor project at Idaho National Laboratory that should result in a high-temperature gas-cooled reactor being constructed.

The South African PBMR project is making progress and construction is planned for 2011.

All these developments point to a positive future for the development and eventual deployment of gas-cooled HTGRs.

Fuel Technology

In December 2008, the IAEA organized the fifth meeting of the CRP on Advances in HTGR Fuel Technology with the participation of 16 participants from 12 Member States. As part of the CRP, participating members received samples of TRISO coated particles to perform quality control measurements for the benchmarking exercise. The samples in this study were all produced on zirconia spheres as a surrogate material for the uranium bearing fuel kernel. Results of the analyses were presented in the meeting. Some differences between the results of the participants are still being investigated. Good agreement in some cases can also be observed. The next and final RCM will take place in September 2009 and it is envisaged that the IAEA-TECDOC will be finalized during that meeting.

Initiating a new CRP on Irradiation Creep in Nuclear Graphite

Numerous creep models have been developed, however, none was demonstrably correct. Yet a clear understanding of the creep phenomenon is central to understanding the irradiation performance of large graphite components. Currently, some Member States have begun investing resources in research work geared towards a better understanding of the creep phenomenon. The Technical Working Group on Gas-Cooled Reactors (TWG-GCR) recommended that a Collaborative Research Programme (CRP) on this topic should receive high priority due to its relevance both to the designers of new HTRs and the life extension safety cases for the currently operating Advanced Gas-Cooled Reactors (AGRs), a Consultancy Meeting aimed to discuss the scope and plan for the CRP on Graphite Irradiation Creep was held in Vienna on 16 – 18 December 2008.The CRP is intended to complement Member States activities and to provide a forum for discussion of the emerging data and the continuing development of creep models. In addition, the CRP will offer advices on follow-up experiments to test the developing theories, the prime objective being to support the operation and design of graphite cores. Currently, 10 Member States have indicated their interest in the CRP.

Contact: b.m.tyobeka@iaea.org.

Technology Development of Fast Reactors and Accelerator Driven Systems

IAEA Fast Reactor Knowledge Preservation Initiative (FRKP).

In collaboration with INIS and NKM, a consultants' meeting was held in November 2008 to coordinate this initiative. The IAEA presented the knowledge management system *Fast Reactor Knowledge Organization System (FR-KOS)* which is a product developed by the IAEA within the framework of the initiative. The following practical recommendations for the future steps in the implementation of the initiative were identified: (i) produce the FR-KOS requirements specification document; (ii) provide the FR-KOS design description document; (iii) define the cost impact associated with the move from open-source to commercial software, under the condition that the end user is provided free of cost access; (iv) establish the Change Control Board that will review, approve or reject change proposals to the FR-KOS, as well as track and manage them; (v) initiate an IAEA Coordinated Research Project (CRP) for the collection of Information Cards (meta-data) from Member States and receiving their feedback on the usability of the FR-KOS.

Fuel Handling Systems of Sodium Cooled Fast Reactors.

An IAEA topical Technical Meeting on Fuel Handling Systems of Sodium Cooled Fast Reactors hosted in November 2008 by the Indira Gandhi Centre for Atomic Research in Kalpakkam, India, offered the opportunity for in-depth information exchange on the results obtained within the various fast reactor research and technology development programs in this field. Fuel handling was identified as a key area for design optimization and cost reduction, and the contributions of the various participants highlighted progress and still unresolved issues in this area. The latter lead to the identification of various proposals for future collaboration under IAEA *aegis* [both information exchange and Coordinated Research Projects (CRPs)], e.g. topical Technical Meetings on maintenance aspects of fuel handling systems of liquid metal cooled fast reactors, on the economics of such systems, on the conceptualization and development of, as well as on the experience with ultrasonic scanner devices for in-service inspection of reactor internals of liquid metal cooled fast reactors, on the operating and testing experience of fuel handing system in liquid metal cooled fast reactors, as well as CRPs on optimum fuel handing temperatures, and on the assessment of handling forces in liquid metal cooled fast reactors.

The participants were also given an update on the status of the construction of India's 500 MW(e) prototype fast breeder reactor (PFBR) (see photographs below).

Installation of the safety vessel into the reactor vault of the 500 MWe PFBR at Kaplpakkam, India, on 24 June 2008 (courtesy of BHAVINI and IGCAR)

Technical Working Group on Fast Reactors (TWG-FR).

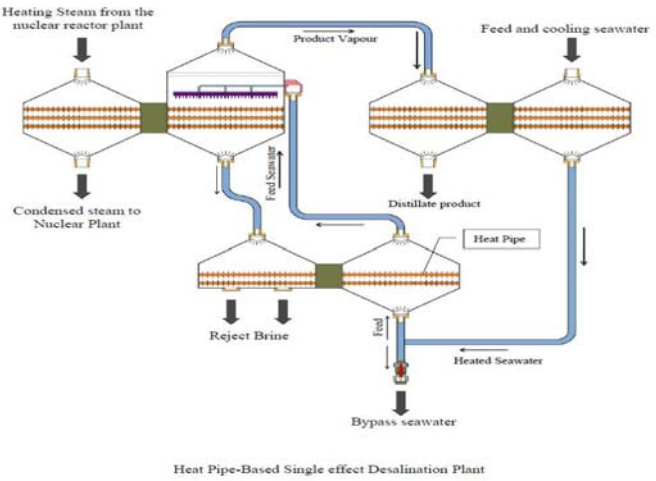
The areas of collaboration between Member States within the framework of IAEA's Project on Technology Advances in Fast Reactors and Accelerator Driven Systems are identified by the Member States through participation in the IAEA Nuclear Energy Department's Technical Working Group on Fast Reactors (TWG-FR). The TWG-FR assists in defining and carrying out the Agency's activities in the field of nuclear power technology development for fast neutron systems. It promotes the exchange of information on national and multi-national programs and new developments and experience, with the goal of identifying and reviewing problems of importance and stimulating and facilitating cooperation, development and practical application of fast neutron systems. The next meeting of the TWG-FR will be hosted by the Indira Gandhi Centre for Atomic Research in Kalpakkam, India, from 25 – 29 May 2009. It will be held as part of India's Department of Atomic Energy events in celebration of the Homi Bhabha Birth Centenary Year (October 2008 to October 2009).

For more information
see www.iaea.org/inisnkm/nkm/aws/fnss/index.html
and contact *a.stanculescu@iaea.org*

Non Electrical Applications of Nuclear Power

Nuclear energy has a high potential for its use in non electric applications where process heat and steam can be produced over a broad temperature range. It contributes about 14% to the world's electricity generation.

In the area of nuclear desalination, the IAEA is launching a new Coordinated Research Programme (CRP) on new technologies for seawater desalination using nuclear energy. Among other prospects of innovative technologies, the CRP will investigate the potential of using new technologies aiming at harnessing waste heat in nuclear power plants using heat pipe technologies for various applications (see Fig. 1). Results of another ongoing CRP on Advances in nuclear power for process heat applications will be presented in 2009. In this CRP, the potential of using high temperature reactors (HTR) not only for electricity generation but also for hydrogen production together and desalination is being investigated. The safety of coupling of HTR to other systems, mainly hydrogen production facility, is also analyzed.



Heat Pipe-Based Single effect Desalination Plant (Jouhara, Khamis)

Nuclear generated hydrogen has important potential advantages in terms of efficiency and cleanliness over other sources considered for a growing hydrogen economy. The Agency continues the development of the Hydrogen Economic Evaluation Programme (HEEP). The HEEP pre-alpha version was released at end of 2008, and the beta version is expected to be released in the first half of 2009.

Other IAEA activities on non electric applications for the 2009 include: the publications of two NE Series technical reports (one on environmental aspects of nuclear desalination, and the other on status of hydrogen production); technical meetings on integrated nuclear desalination systems and non electric applications, the Technical Working Group on Nuclear Desalination (TWG-ND), on Hydrogen production; the release of newly modified version of the Desalination Economic Evaluation Programme (DEEP); and the development of "a toolkit" on nuclear desalination.

Contact: *I.Khamis@iaea.org*.

Highlighted Events

Workshop on Erosion-Corrosion including Flow Accelerated Corrosion (FAC) and Environmentally Assisted Cracking Issues (EAC) in Nuclear Power Plants
Moscow, Russian Federation, 21 - 23 April 2009

FAC/EAC is now considered one of the most important issues to be addressed in order to predict remaining service life and confirm the structural integrity of components as part of the safety assessment for plant life management and safe long term operation. For more information please visit:

http://www.iaea.org/NuclearPower/PLIM-LTO/plim_TMC_Moscow_Apr2009.html

Workshop on Heavy Component Replacement in Nuclear Power Plants
Lynchburg, VA, USA 26- 28 May 2009

This workshop will be dedicated to heavy components replacement considered strategic for nuclear power plants life management. For more information please visit:

http://www.iaea.org/NuclearPower/PLIM-LTO/plim_TMC_Lynchburg_May2009.html

9th IAEA - FORATOM Joint Workshop Offenbach, Germany, 22 - 25 June 2009

This international workshop will cover Practical Implementation of IAEA safety standards on management systems. Its objective is to promote the IAEA safety standards on management systems (GS-R-3, GS-G-3.1 and DS349) and to provide a practical approach of the implementation of an integrated Management System in existing Management Systems in nuclear facilities and activities.

Contact: J. Majola: *j.majola@IAEA.org*, P. Vincze: *p.vincze@iaea.org*.

International Conference on Opportunities and Challenges for Water Cooled Reactors in the 21st Century, Vienna, Austria, 27- 30 October 2009

Current world challenges such as energy demand, climate change, and energy security are opportunities for the nuclear industry. Many projections forecast significant growth in nuclear power both in countries currently using it and in countries considering its use for the first time. For more information please visit:

www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=35251

International Conference on Fast Reactors and Related Fuel Cycles: Challenges and Opportunities (FR09), 7 – 11 December 2009, Kyoto, Japan.

The conference will cover new reactor concept designs and associated objectives and driving forces, strategies for actinide recycle, economics, safety, advanced fuels, innovative technologies, past experience, availability of experimental facilities, human resources, infrastructures and knowledge management. For more information please visit:
www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=35426

Upcoming Meetings

Date	Contact	Title	Location	Country
01-03 Apr-09	i.facer@iaea.org	Standing Advisory Group on Nuclear Energy	Vienna	Austria
14-17Apr-09	v.nkong-njock@iaea.org	TM on Industrial Capacity Development	Vienna	Austria
21-23 Apr-09	k.s.kang@iaea.org	TM/Workshop on Erosion-Corrosion (E/C) including Flow Accelerated Corrosion and Environmentally Assisted Cracking (EAC) Issues in NPPs (http://www.iaea.org/NuclearPower/PLIM-LTO/plim_TMC_Moscow_Apr2009.html)	Moscow	Russian Federation
20-22 May-09	o.glockler@iaea.org	Technical Working Group on NPP Control and Instrumentation (TWG-NPPC&I)	Vienna	Austria
25-29 May-09	a.stanculescu@iaea.org	Technical Working Group on Fast Reactors (TWG-FR)	TBD	TBD
27-29 May-09	k.s.kang@iaea.org	TM on Methods and Experiences of Heavy Component Replacements in NPPs (http://www.iaea.org/NuclearPower/PLIM-LTO/plim_TMC_Lynchburg_May2009.html)	Lynchburg, VA	USA
02-05 Jun-09	a.kazennov@iaea.org	TM on Simulators, Advanced Training Tools and Technologies for the Nuclear Industry	Vienna	Austria
8-11 Jun-09	j.mandula@iaea.org	TM on Country Nuclear Power Profile	Vienna	Austria
08-10 Jun-09	i.khamis@iaea.org	TM of the Technical Working Group on Nuclear Desalination (TWG-ND)	Vienna	Austria
09-11 Jun-09	x.li@iaea.org	TM on the Preparation and Evaluation of Bids for NPP Projects	Vienna	Austria
22-26 Jun-09	J.H.Choi@iaea.org	Course on Natural Circulation Phenomena and Modeling in Water Cooled Nuclear Power Plants	Pisa	Italy
23-26 Jun-09	a.stanculescu@iaea.org	RCM on Analyses of and Lessons Learned from the Operational Experience with Fast Reactor Equipment and Systems	Vienna	Austria
23-26 Jun-09	v.kuznetsov@iaea.org	TM to Coordinate Case Studies on Competitiveness of Small and Medium Sized Reactors in Different Applications	Vienna	Austria
07-09 Jul-09	i.khamis@iaea.org	RCM on Advances in Nuclear Power Process Heat Applications	Vienna	Austria

For more information on IAEA Meetings, please visit:

http://www-pub.iaea.org/MTCD/Meetings/PDFplus/current.pdf

Vacancy Notice for Professional Posts

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

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

BEIJING International Ministerial Conference 20-22 April 2009

"Nuclear Energy in the 21st Century"

This conference has been extended from two days to three days to allow more detailed discussion of issues of importance to the future of nuclear energy. Many Ministers have indicated their intention to participate and to speak at the conference; in addition, the conference will include sessions to discuss major issues as follows:

Monday, 20 April

Energy resources and the environment.

Discussions will be held on climate change impacts; the potential role of nuclear power and options for sustainable energy mixes in different national conditions; including discussions on energy, social, economic, environmental and development issues, and the potential role of nuclear energy.

Tuesday, 21 April

Available technology and the long term perspectives.

This session will include discussion of current designs, the availability of manufacturing facilities, potential technical impediments to expansion programmes, improving safety levels in new designs, the future availability and potential role of different reactor designs. The latter may also include a discussion of the use of nuclear energy for non-electricity producing applications such as desalination or process heat. The discussion will also address safety, security and safeguards requirements associated with the increasing use and spread of nuclear energy, including technological and institutional issues and solutions.

Infrastructure development and safety and legal issues

This session is an opportunity to discuss the range of infrastructure challenges that countries considering introducing nuclear power may face, and the options available to meet these challenges. Considerations of the implications of infrastructure development for achieving safety and regulatory objectives will also be discussed. The legal issues associated with preparing for a nuclear energy programme will also be addressed.

Wednesday, 22 April

Reliable fuel supply, spent fuel and waste management and strengthening non-proliferation.

This session will cover discussions on the security of energy supply in general, addressing current and future trends in the availability of nuclear fuel, including the security of nuclear fuel supply. This topic will also allow for discussions regarding options to reduce the spread of spent fuel and waste storage facilities. The role of national and international organizations and of industry in supporting nuclear energy development will also be discussed.

All the above issues will be presented by internationally recognized experts, followed by panel discussions with and among the participants.

Contacts: I.Facer@iaea.org; M.Bermudez-Samiei@iaea.org; K.Morrison@iaea.org

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