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Nuclear Power Newsletter

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NENP's Activities to Support New Countries

The IAEA continues to see rising expectations as to the role of nuclear power. Hence, the IAEA considers eight key challenges for successful expansion of nuclear power in the near-term. Today, more than 60 new countries informed the IAEA, through various channels, that they are considering embarking on nuclear power programme. The IAEA has a role under its statute to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. At the same time, the IAEA needs to ensure protection, that, wherever nuclear energy is used to produce electricity (or for district heating, desalination, or hydrogen production), it is used safely, securely, and with minimal proliferation risk. The IAEA has to take a leadership role in these efforts and to ensure that the needs of developing countries are taken into account.

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Future of Nuclear Power

A commitment to Nuclear Power requires a perspective spanning decades and even centuries. Predicting the future is likely to be filled with rather large uncertainties. However, there are several trends that could impact the growth and direction of Nuclear Power during the 21st century.

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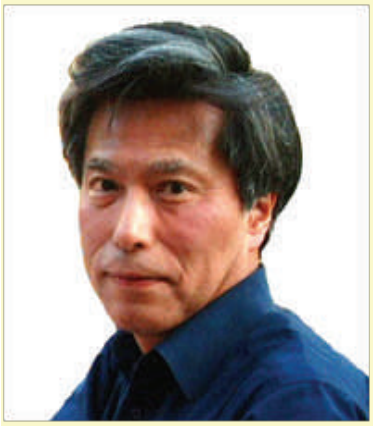
Message from the Director



Welcome to the September issue of the Nuclear Power Newsletter.

By following the tradition that the September issue carries focused articles rather than simply reporting Agency's activities and documents in the last three months, this issue has three key articles: support for newcomer's nuclear power programmes, support for the existing fleet, and the future of nuclear power. This is because we want to reach out to the delegations coming to the General Conference in September and present the core of NENP activities.

Time has passed very quickly since I started serving the Agency in early 2004. The first thing I did was plan for the Programme and Budget for 2006 and 2007. However, in retrospect, we had not fully expected the sweeping change in this budget period, in which many developing countries expressed their interest in nuclear power and requested the Agency's support. In fact, in the Agency's Nuclear Technology Review 2005 report, we called the year 2005 the year of rising expectations as to the role of nuclear power. This went on until the number of countries that have expressed interest in launching nuclear power programmes has reached close to 70 and the number of Technical Cooperation programmes tripled in 2009.

Accordingly, the programmatic activities of NENP changed so as to provide more emphasis on newcomer's support by publishing guideline documents, Technical Cooperation projects, conducting workshops and other support activities. I feel very happy that I have worked for NENP in this time period. My view is that we have almost completed the important publications and it is now time for implementation, for newcomers to build sound infrastructure and for the Agency to conduct more field work to support them. However, I do not necessarily feel everything is going very well. The increasing gap between the number of TC projects and the number of regular budget staff made me occasionally feel our support programme may not be sustainable. Also, I felt some worry about ownership and responsibility in some newcomer countries' nuclear power programme implementation.

I was recently in Jordan as the head of an Integrated Nuclear Infrastructure Review (INIR) mission (see page 7), which is intended to review the status of infrastructure development, measure the distance to the expected milestones, and discuss areas of cooperative works to fill in the gaps. I am very glad to tell you that this was a very successful mission with full cooperation from Jordan and I am convinced that INIR benefits both the recipient and the Agency significantly. I would like to urge newcomers to consider inviting INIR missions in order to support building up sound infrastructure efficiently and effectively by addressing identified gaps.

Of course there are two other pillars of NENP activities but I am not going to touch on them in my message. I simply would like to say that all the activities in NENP benefited very much from contributions by external experts and I cannot thank them enough. I strongly believe that international cooperation, as well as regional cooperation, is a key for successful nuclear power programmes for newcomers. We still do not see much regional cooperation in this area and I would encourage more programmes to think about it.

Now, let me switch gears to introduce my successor: Mr. Jong-Kyun Park, who was a Vice President in charge of Nuclear Policy and International Relations of KAERI (Korea Atomic energy research Institute) in the Republic of Korea. He will take up his duties effective October 1 2009. He has Ph.D. degree in Nuclear Engineering and Science from Rensselaer Polytechnic Institute in the USA. After working for Combustion Engineering and Long Island Lighting Company at Shoreham Nuclear Power Station in the US, he went back to the Republic of Korea to work for KAERI. While at KAERI he had extensive experience including Advanced Nuclear Technology Development, Nuclear Hydrogen Development, and Nuclear Policy and International Relations.

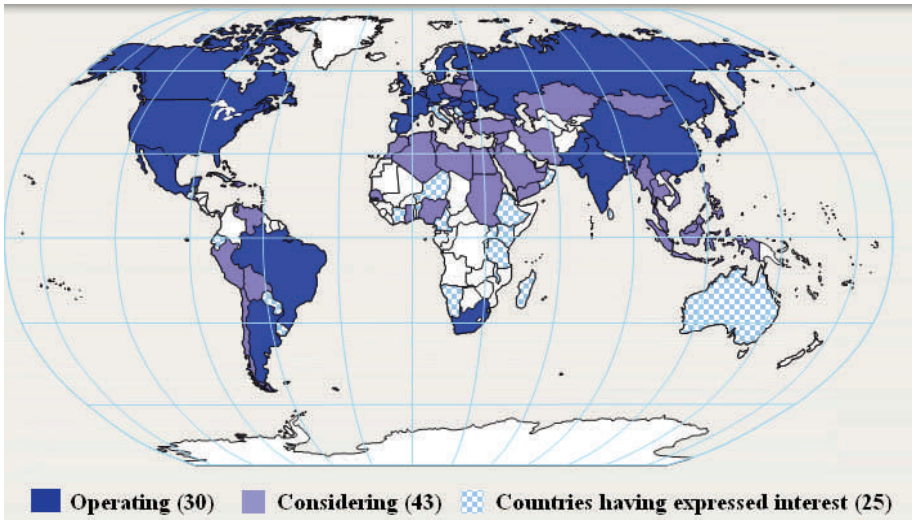
I want to ask for your continued support for the activities in NENP, and wish you to extend your support to my successor.

All the best.
Akira OMOTO

NENP's activities to support new countries

The IAEA continues to see rising expectation concerning to the role of nuclear power. The IAEA considers the following eight areas the key challenges for successful expansion of nuclear power in the near-term:

1. Safety and reliability
2. Economic competitiveness and financing
3. Public acceptance
4. Uranium resources
5. Fuel and waste management
6. Human and industrial resources
7. Proliferation risk and security
8. Infrastructures, especially in new countries.



As for the new countries, today there are more than 60 countries, which, through various channels, have informed the IAEA that they are considering embarking on nuclear power programmes. They are considering nuclear power as one of the options to meet their growing energy demands while considering issues of energy security and global environment. The accumulated experience and good operational performance of the existing nuclear power plants also seems to have influenced this consideration.

The IAEA has a role under its statute to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. At the same time, the IAEA needs to ensure that, wherever nuclear energy is used to produce electricity (or for other non-electric applications as desalination, hydrogen production, district heating, or others), it is used safely, securely, and with minimal proliferation risk. The IAEA has taken a leadership role in these efforts to ensure that the needs of developing countries are taken into account.

IAEA support for nuclear infrastructure building

The IAEA's support for nuclear infrastructure building is basically intended to assist capacity building in the newcomer country through technical cooperation projects so that they can stand by themselves and is expected to include:

- Providing tools for informed decision-making through guidance documents, forums, and analytical tools, and
- Building on the process through review services such as site evaluation, design evaluation, etc.

Practically, assistance is given in the form of review missions, workshops, seminars and scientific visits. Popular topics include but are not limited to; review of feasibility study, review of draft nuclear law, regulatory framework and organization, site survey and site evaluation, human resources development plan, bid tendering and evaluation, owner/operator's competence building, regulator's competence building, reactor technology assessment.

In providing guidance, the IAEA is recommending:

- Use of the IAEA guidance documents & services
- Conducting an energy planning before considering a nuclear programme
- Full understanding of the obligations and necessary long-term commitment in the initial phase before a decision is made to adopt nuclear power
- Consider adopting international instruments prior to beginning a new nuclear power plant project including safeguards agreement, additional protocol, as well as various conventions on safety
- Sound infrastructure for safe, reliable and efficient use of nuclear power under a holistic approach
- Not only preparing a framework, importance of addressing safety culture and ownership/responsibility of owner/operator
- Continuous self-assessment of infrastructure status
- Consider regional approach for efficiency, and
- Consider important roles to be played by the Government.

Guidance documents

Since the early 1980s, a considerable number of IAEA publications have been released to guide the introduction of nuclear power in newcomer countries. Although not intended specifically for newcomers, there are numerous standards, guides, international instruments, technical reports etc. that provide important information for those considering a nuclear power programme and building national infrastructure. These are compiled under the IAEA Nuclear Safety Standards Series, IAEA Nuclear Security Series, IAEA Nuclear Energy Series, IAEA International Law Series, IAEA Safeguards Information Series, IAEA Nuclear Verification Series and others, all of which are available on IAEA web site.

The NENP does not producing these documents in isolation. Many of the above mentioned publications have been produced by divisions other than the Division of Nuclear Power (NENP). In preparing new publications in support of infrastructure building for new countries, NENP has been working together with other parts of the IAEA having different expertise. In addition, many of these publications have also benefited from the expertise of external experts that participated in their preparation. When providing guidance with a focus on newcomers in the contemporary situation, the approach of the IAEA since 2005 has emphasized:

(1) Providing holistic guidance to support balanced development of the various elements of infrastructure in a way that there are no important missing issues,
(2) Utilizing accumulated experience and lessons learned from 30 nuclear power operating countries, and
(3) Introducing a phased approach to enable progressive development of the country's nuclear infrastructure.

The IAEA brochure entitled Considerations to Launch a Nuclear Power Programme (March 2007) and the IAEA Nuclear Energy Series publication NG-G-3.1 on Milestones in the Development of a National Infrastructure for Nuclear Power (September 2007) discuss complex and interrelated nineteen infrastructure issues, recommend a phased approach for the progressive development of infrastructure and clarify the conditions that are expected to be met at the end of each phase (milestone).

Following the completion of the Milestones publication, the IAEA Member States requested additional guidance on how to assess the progress of their infrastructure development. A new publication entitled Evaluation of the Status of National Nuclear Infrastructure Development (Nuclear Energy Series NG-T-3.2) was published in November 2008 to enable continuous self assessment of the newcomers by providing a detailed basis for evaluation over the nineteen topical issues of infrastructure. Member state's continuous self-assessment against the evaluation basis is intended to help identify gaps and areas of assistance from outside and for a wise and effective investment of resources in that country.

Furthermore the IAEA has published many guidance publications recently and has pipeline publications on various topics such as regional sharing of nuclear infrastructure, management of nuclear power plant projects, financing, national organization to lead a national nuclear programme, workforce planning, interface with electricity grid, alternative approach for contracting and ownership, stakeholder involvement, technology assessment construction technology, etc. The recently published INSAG-22 defines elements of safety infrastructure under a phased approach.

INPRO assessment methodology and its manual can be applied for screening an innovative nuclear system (INS), comparing different INS to find a preferred INS consistent with the needs of a given state, by analysis of the INS in the light of basic principles, user requirements and criteria in the context of economics, environment, fuel cycle and waste, safety, proliferation resistance and infrastructure. Several countries have already finished the assessment of candidate INSs using this methodology, which will soon be available as working material.

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Support to Operating Nuclear Power Plants

Many Member States have given high priority to continued operation of NPPs beyond the timeframe originally anticipated (e.g. 30 or 40 years). Out of a total of 436 operating nuclear power plants, 327 have been in operation for more than 20 years (as of July 2008). The need for engineering support for operation, maintenance, safety review, life management for long term operation and education/ training is increasingly evident.

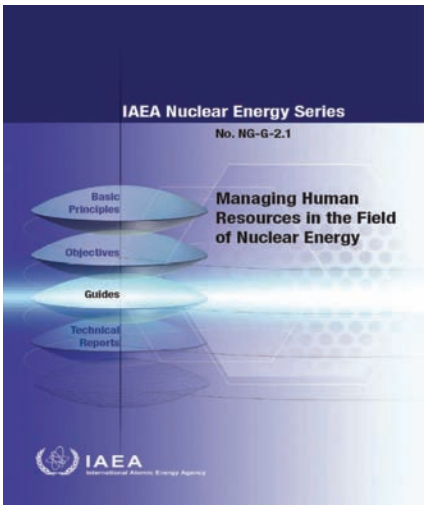
The Agency has been working to improve engineering support in operation, maintenance, safety reviews, and plant life management for long term operation with other international organizations. Four new Nuclear Energy Series (NES) reports were published for heavy component replacement, on-line monitoring for improving performance, and role of instrumentation and control systems in power uprating projects.

A technical report on Application of Reliability Centered Maintenance to Optimize Operation and Maintenance (IAEA-TECDOC-1590) was published focusing on the functionality of the plant and equipment and the critical failure mechanisms.

As an increased number of plants age, there is increased demand from IAEA Member States for improved methodology for optimization of investment (cost-effectiveness and timing of refurbishment & linkage with power up-rating) and reduced uncertainties in the prediction of component degradation. The IAEA provides the following support, but is not limited to:

- A forum of information exchange by compilation of good practices & lessons learned
- Safety standards and technical guides/guidelines
- Component-wise degradation mechanisms and prediction methods.
- Review services.

The advent of I&C technology makes other technologies utilized for nuclear power stations obsolete and operators of nuclear power plants find difficulty in replacing components. For sharing relevant operating experience and its use in licensing decisions, the IAEA has several recent publications on the role of I&C systems in power uprating, on-line monitoring, the implementation of digital I&C, etc.



The Division of Nuclear Power conducts a wide range of activities to support Member States in acquiring competent staff for various organizations and for various phases of nuclear facility cycle, including construction, commissioning, operation and decommissioning. Special attention is paid to the support in workforce planning and human resource development in the countries embarking on nuclear power and building the first nuclear power plant.
A new nuclear energy series guide on Managing Human Resources in the Field of Nuclear Energy has been published recently, and serves to communicate a message to all stakeholders of the nuclear industry on the importance of the adequate human resources for safe and efficient operation of the nuclear industry and on the essential activities to be undertaken in order to reliably supply the competent workforce.

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Future of Nuclear Power

A commitment to Nuclear Power requires a perspective spanning decades and even centuries. Predicting the future is likely to be filled with rather large uncertainties. However, there are several trends that could impact the growth and direction of nuclear power during the 21st century. The three major issues that will impact the future of nuclear power are:

- the growth of nuclear power
- the availability of future nuclear technologies
- developments in other energy and industrial sectors

This article focuses on the different nuclear technologies and the activities that the Agency is involved in this area.

The growth of nuclear power is not uniform globally and the technical solutions are also different. The largest growth is currently focused in a few countries with large populations and energy demand (like China and India). Some countries are adding capacity at a slower rate (like Rep. of Korea, Japan, Russian Federations, Finland etc.), while others are completing units that had been postponed earlier (Romania, Argentina etc). The countries with the largest nuclear fleets are seriously considering expanding their existing capacity (like USA and France). On the horizon several countries are considering starting new programs or expanding existing ones (Brazil, Bulgaria, etc).

Most of the growth in the near term is expected to result from the deployment of water cooled reactors – both light water and heavy water. However, a few countries (India and Russian Federations) have fairly ambitious plans to introduce fast reactors systems commercially in the shorter term. There is also some discussion of introducing high temperature reactors for niche and/or process heat applications in the medium term. In summary, even with the globalization of the nuclear power enterprise, there are significant variations in the growth and technology options among different countries (see Fig. 1 for France and 2 for India).

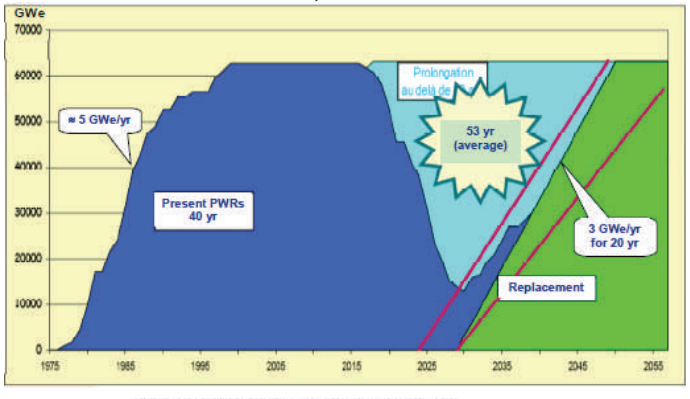

Fig.3 Future water cooled and fast reactors deployment scenario for France

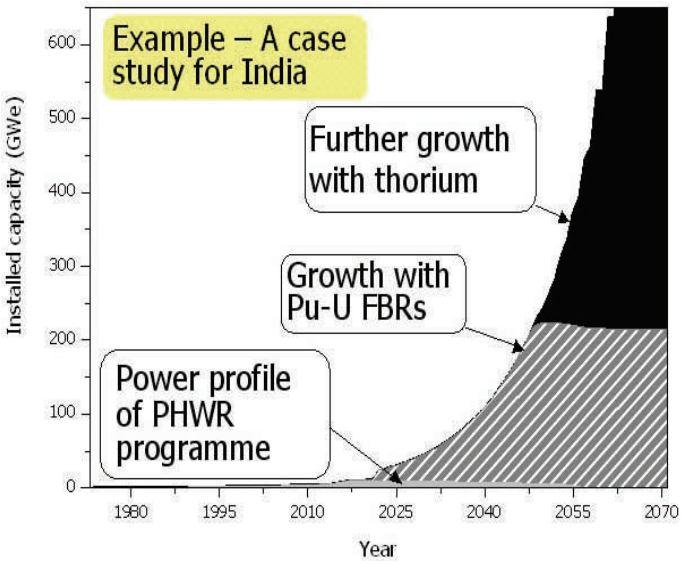

Fig. 2 Different technology options –thermal and fast reactors

The Agency provides assistance to Member States to develop their capabilities to study and develop different technology options under Technical Working Groups for:

- Water cooled reactors s.bilbao@iaea.org
- Fast reactors a.stanculescu@iaea.org
- Gas cooled reactors b.m.tyobeka@iaea.org
- Small & medium reactors v.kuznetsov@iaea.org
- Non-electric applications i.khamis@iaea.org
- Assess different growth scenarios under INPRO contact: v.usanov@iaea.org

Since the Member States develop actual plant designs and perform the supporting research and development, the Agency's activities in all the reactor areas are focused on ensuring that the information about the designs is readily available to all Member States. The Agency focuses on providing training to Member States in the new technologies and it provides a continuous forum to share research results in areas of common interest (through coordinated research projects, technical meetings, workshops and reports).

The activities focus on identifying major trends that may be of a common interest (such as economics, performance, materials, availability of fissile materials globally, passive safety systems, benchmarking of computer codes etc). There is also a focus on sharing best practices among Member States on various issues including construction technologies, operational experiences and technology development. Since the Agency represents all Member States, it is the best forum for this kind of global activity. The Agency does however recognize t hat since most of the research and development activities are performed in Member States, it has to provide creative means to share the technical information objectively and comprehensively.

The Agency's activities on global scenarios (under INPRO) have the potential to define institutional and infrastructure arrangements to enable global use of innovative nuclear energy systems. The Agency also seeks synergies with other international organizations (even though they may not be open to all Member States) that are focused on research and development.

Water cooled reactors, both heavy water and light water, are likely to continue being the backbone for both near term and longer term nuclear power applications for several reasons:

- Proven, reliable and economical
- Easy to operate and maintain
- Human resources to design, build and operate them are abundant
- Majority of plant components can be built locally
- Available from multiple suppliers
- Needed to provide fissile material for fast reactors
- Mixed oxide and thorium fuels can be used
- Available in different sizes – from small to large
- Safety of these plants has been established and accepted
- Ongoing developments for the future designs – like floating reactors (r.beatty@iaea.org), super critical reactors etc. (contact: s.bilbao@iaea.org)

Fast reactors are likely to be the next major reactor line to be deployed in substantial numbers (see Fig.3). There is already substantial operating experience with these reactors over the last 50 years and there are 4 fast reactors that are currently operating-from prototype to commercial size. Two countries (Russian Federations and India) are building additional commercial size reactors in the 500 to 800 MW(e) range. The interest in these reactor designs stems from the fact they have the following advantages:

- Optimization of fuel utilization (fissile resources)
- Reduce the toxicity and amount of waste

However, the large scale application of these reactors has been limited as they have several challenges that still need to be addressed:

- Economics relative to water cooled reactors
- Processing and manufacturing issues related to the fuel cycle
- Materials and operational issues
- Institutional issues

The development and deployment of these reactors is being led by countries that see the need to diversify the fuel supply away from uranium based fuels to utilization of the plutonium produced in water cooled reactors and the possible use of breeding to expand the utilization of all fissile resources. Deployment scenarios among the different countries range from commercialization in 2020 to 2050.

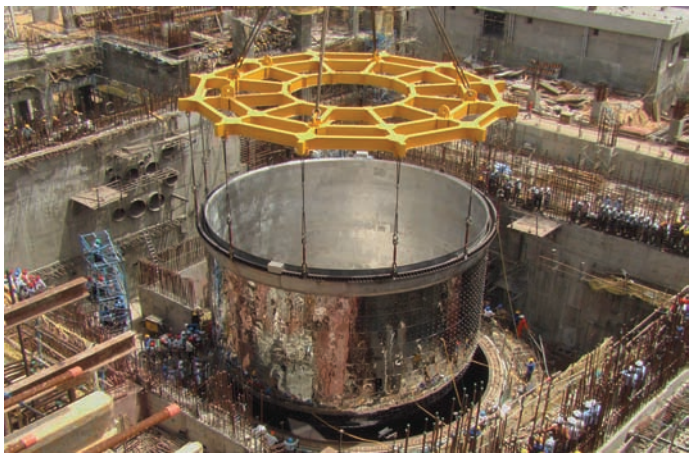

Fig. 3 On-going construction of the 500 MW(e) fast reactor in India.

Gas cooled reactors have also been deployed globally for electricity generation for almost 50 years but the future interest in these reactors is tending towards their potential use in processes requiring high temperatures like hydrogen generation, enhancing coal gasification, oil recovery in tar sands etc. The USA, China and South Africa are currently the leading countries in the quest to deploy a high temperature reactor by 2018, with China leading the pack and expecting to pour first concrete in 2009. China's reactors are geared towards electricity production. France has a long term plan to use gas-cooled fast reactors for process heat applications.

For countries with small and medium sized grids, utilizing nuclear power requires different considerations than those with large grids, which can practically utilize the range of reactors available in the larger size ranges. For these smaller grid countries there are fewer proven reactor designs available. However, these available reactor designs have been found to be practical and economical where they have been applied. In order to address this need among many countries several designers have undertaken development programmes to increase the options available. It is too early to address the commercial viability of these programmes, but a few are now at the advanced stages, e.g. the floating plant (KLT-40 in Russian Federations) has recently completed the construction of the first two reactors on the barge.

Non-electric applications are one of the big unknowns in the future application of nuclear power. There is obviously tremendous near term potential for the use of nuclear power to generate electricity and simultaneously produce potable water (defined as co-generation). There is a tremendous need for potable water in several regions of the world. The Agency has conducted several studies to address the key issues that might arise in this application and has just released and made available for Member States a toolkit on nuclear desalination to help them perform their own assessment on the economics of this co-generation option. The Agency is also addressing nuclear hydrogen generation as part of this activity, and will soon release the beta-version of the Hydrogen Economic Evaluation Programme (HEEP). In summary, the future of nuclear power is entirely dependent on the activities in the member countries which are focused on the development, design and deployment of different reactor designs. The directions and technology options will more than likely be driven by individual country needs and requirements, but hopefully this will result in global solutions that address all country needs. The Agency will continue to play the role of enhancing the exchange of this information, increasing collaboration and enhancing capacity building in all member countries, while enhancing the sharing of best practices.

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First INIR Mission: Helps Jordan Identify Issues and Focus Assistance

An IAEA Integrated Nuclear Infrastructure Review (INIR) mission visited Jordan from 4-6 August 2009, and found that the country has made significant progress in its preparation for nuclear power. The mission also identified areas in which assistance from the IAEA and other international organizations will need to focus as Jordan builds the institutions that will implement its nuclear programme.

"The INIR mission is an opportunity to review the Jordanian programme and to identify areas to focus national efforts, IAEA technical cooperation and other international assistance," says Akira Omoto, Director of the IAEA´s Nuclear Power Division and team leader.

The INIR mission was carried out based on the evaluation methodology outlined in the publication *Evaluation of the Status of a National Infrastructure Development*, which developed from *Milestones in the Development of a National Infrastructure for Nuclear Power*, and other relevant publications. Prior to the INIS mission, Jordan completed a self-evaluation and sent it to the IAEA.

"Jordan benefited from the self evaluation and INIR mission because it helped us identify issues and focus on future areas for assistance," said Dr. Kamal Araj, Vice Chairman of the Jordanian Atomic Energy Commission. "It has helped us move forward toward our goals, and we plan to invite a follow-up INIR mission before we go out for bids", he adds.

Self-evaluation and international peer reviews reenforce continual improvement in the planning process, identify gaps and focus resources, and build confidence in a country´s infrastructure development. The INIR mission to Jordan was conducted by a team of IAEA staff, international experts and Jordanian officials. Several countries have expressed an interest in hosting INIR missions in 2009 and early 2010.

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Upcoming Meetings

Date	Contact	Title	Location	Country
01-04 Sep-09	j.majola@iaea.org	TM on Management System Considerations for Developing Nuclear Power Programmes	Vienna	Austria
12-14 Oct-09	i.khamis@iaea.org	TM on Status of Hydrogen Production	Mumbai	India
12-23 Oct-09	s.bilbao@iaea.org	Workshop on Nuclear Power Plant (NPP) Simulators for Education	Trieste	Italy
27-30 Oct-09	s.bilbao@iaea.org	International Conference on Opportunities and Challenges for Water Cooled Reactors in the 21st Century (http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=35251)	Vienna	Austria
03-05 Nov-09	m.aoki@iaea.org	Workshop on Nuclear Power Newcomers and International Cooperative Actions	Vienna	Austria
03-06 Nov-09	v.kuznetsov@iaea.org	TM on Options to Enhance Proliferation Resistance and Security of NPPs with Innovative SMRs	Vienna	Austria
09-11 Nov-09	p.gowin@iaea.org	15th INPRO Steering Committee Meeting	Vienna	Austria
11-13 Nov-09	p.gowin@iaea.org	INPRO Dialogue Forum	Vienna	Austria
12-13 Nov-09	b.tyobeka@iaea.org	TM of the IAEA Graphite Knowledge Base	Vienna	Austria
23-26 Nov-09	s.bilbao@iaea.org v.inozemtsev@iaea.org	TM on Advanced Fuel Pellet Materials and fuel Rod Designs for Water Cooled Reactors (http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=35292)	Villigen	Switzerland
07-11 Dec-09	a.stanculescu@iaea.org	International Conference on Fast Reactors and Related Fuel Cycles—Challenges and Opportunities (FR09)	Kyoto	Japan
14-18 Mar-10	t.mazour@iaea.org Y.yanev@iaea.org	International Conference on Human Resource Development for Introducing and Expanding Nuclear Power Programmes	TBD	United Arab Emirates

For more information on IAEA Meetings, please visit:

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

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