Akira OMOTO

Director of the Division of Nuclear Power, IAEA

"Some Asian countries have very ambitious nuclear expansion plans: China six fold by 2020; India nine fold by 2022"

Mr. Akira Omoto is a Director of the Division of Nuclear Power at IAEA since January 2004. As a director, he works in support of excellence in operation of existing nuclear reactors and reactor technology development including INPRO.

Before working for the IAEA, he was a General Manager of the Department of Nuclear Power Engineering of The Tokyo Electric Power Company, one of the utility companies in JAPAN with a fleet of 17 BWR units.

He graduated from the Department of Nuclear Engineering of the University of Tokyo and received his doctoral degree from the same university.

1. These days we see the media is reporting "Nuclear Renaissance". Is "renaissance" there? What is the current status and future prospect of nuclear power?

Certainly, we see today rising expectation to the role of nuclear power in much of the world, but a renaissance is not yet reality, I mean, many countries are considering constructing new nuclear plants, but only a few have started construction recently.

Currently there are 443 nuclear power plants under operation in the world supplying 16% of electricity, but as shown in *Fig.1*, nuclear capacity growth has stagnated since the middle 1980s. For instance, the number of new plants starting construction is 1-6 units/year in the 2000-2005 period, which is a sharp contrast to the 25 units/year average in the 1970's. So, in the context of new capacity additions to meet growing energy demand, it is not yet a "renaissance".

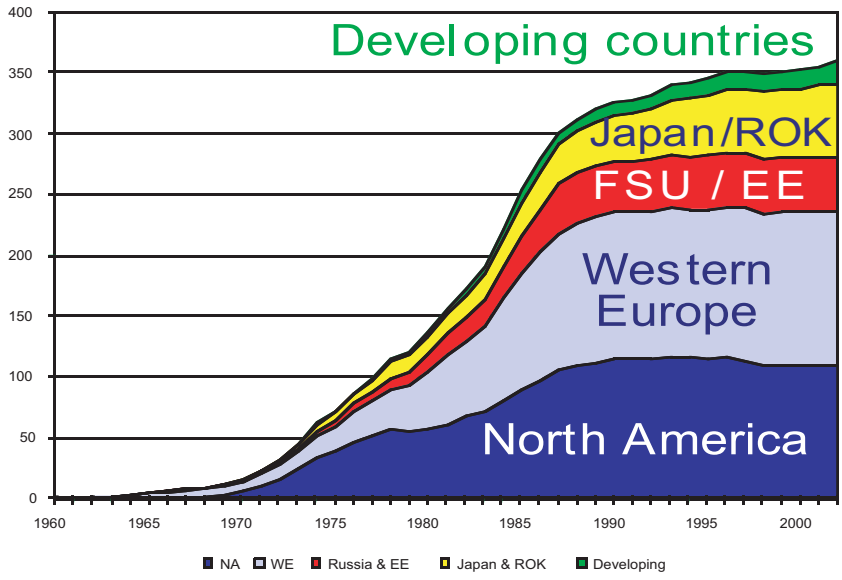


Fig-1 History of nuclear capacity additions

The IAEA is receiving many requests to assist their energy planning, including nuclear power in general, and possible first nuclear power plants in particular, from Member States currently not operating any nuclear power plant.The background for such increased interest includes;

- Growing energy demand
- Growing concern over energy security
- Growing environmental concern, as reflected especially in Kyoto Protocol's entry into force in February 2005
- Accumulated experience and good operational performance of nuclear plants (more than 83% availability on average)

Let us look at Asia as an example. There are many Asian countries considering their first nuclear plant construction, and there are ongoing expansion plans in other countries. Out of 27 new units under construction in the world, 16 are in Asia; 8 in India, 5 in China (including 2 in Taiwan), 1 in Japan, 1 in Pakistan, and 1 in Iran.

There is growing demand for energy in Asia in order to support economic and population growth, which in turn require growth in per capita energy consumption for a better quality of life. For instance, India needs additional capacity of 10 GWe/yr to support GDP growth (7%/a). And one must remember that, in China and India, per capita electricity consumption is only 1/8 and 1/13 respectively of that in OECD countries.

Also, the Asia Pacific region has a scarcity of resources, such as oil and gas compared with other regions. Recent hikes in oil prices have fuelled concern over energy security.

Against this background, some Asian countries have very ambitious nuclear capacity expansion plans: China plans to increase six fold by 2020; India nine fold by 2022.

Although the new capacity additions since the mid-1980s have been relatively small, nuclear electricity's share has remained around 16%, meaning nuclear electricity generation increased by 40% during this time period. This is due to the combined effect of availability increases, capacity additions and power uprating. (*Fig-2*)

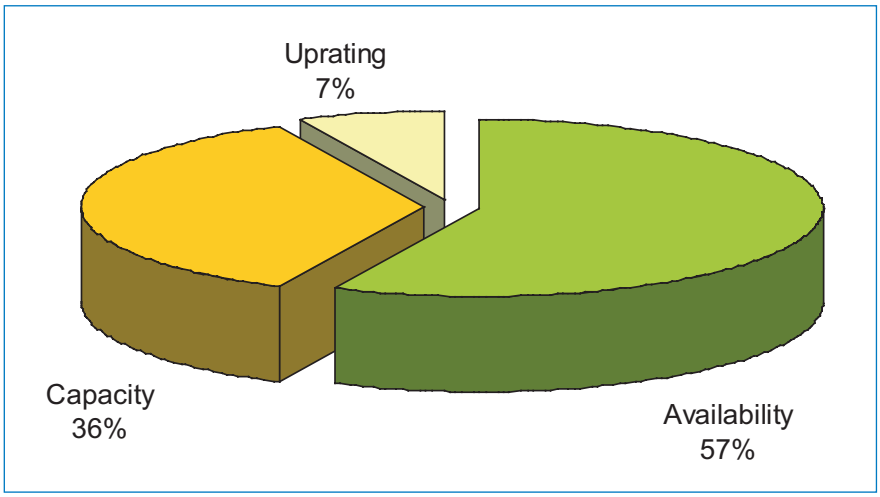


Fig-2 Contribution to the growth of nuclear electricity in 1990-2004

"Although the new capacity additions since the mid-1980s have been relatively small, nuclear electricity generation increased by 40% during this time period."

Underlying the availability increase are such factors as increased information exchange among operators to enable them to emulate best practice, risk-informed performance-based regulation especially in the US, and consolidation in the industry such that more nuclear plants are being operated by those who do it best.

This improvement in operational performance is accompanied by improvements in safety performance such as a continuous decline in unexpected shutdowns and the number of challenges to safety systems. In this context of improved performance, a "renaissance" might be there.

In the EU, nuclear power is currently displacing 700 tones of CO_2 emissions per year, which is equivalent to the CO_2 emitted by all the cars in Europe.

2. What is the projections of growth?

There are medium term projections and long term projections.

An example of the medium term projections is the US DOE's International Energy Outlook, which predicts that nuclear power will grow only very slightly through 2030 (0.4% on average). Given the generic increase of energy consumption, especially in developing countries, nuclear power's share of electricity would decline in this case.

The IAEA's projections (RDS-1; Energy, Electricity and Nuclear Power Estimates for the Period up to 2030) shows that although there will be 20-70% increase in the nuclear power generating capacity, its share of the global production of electricity would decline.

In contrast, long-term projections using economic models such as by IPCC (SRES report in 2000 or MIT report in 2003) predict a big increase by 2050; for instance the median of the 40 scenarios of SRES is that nuclear capacity will increase five fold by 2050 and is above both IAEA projections.

3. What are the initiatives and challenges of Nuclear Power programs in the IAEA in response to the rising expectation?

The Agency supports Member States nuclear power programme in various ways, but not limited to those;

- providing a forum of information exchange to help informed decision-making by dissemination of good practices through computer tools, document, workshops, seminars etc.,
- providing safety standards and review missions using these standards as a technical basis,

- providing technology transfer through technical cooperation projects.

Continued vigilance to safe, reliable operation of existing nuclear power plants and to international safeguard regime are of course vital elements and are prerequisites.

Typical thematic areas of support include energy planning, enhanced safety through innovation, reducing uncertainties associated with waste disposal, assistance to uranium exploration and so on.

In support of those countries considering first nuclear power plant or the expansion from a small number of units, infrastructure building in the nation or region will be a key.

In contrast to physical (industrial capacity), soft infrastructure involves aspects such as legal and institutional (legal framework, regulation, liability & insurance schemes, IAEA Safeguards agreements, security arrangement, international conventions), securing resources (capital, competent engineers, Uranium) and socio-political elements (stable and good governance, public acceptance, public participation in the decision-making).

"Nuclear safety worldwide still faces occasional serious problems such as in Davis-Besse and Paks."

The IAEA has been working in support of Member States' needs in this area and is considering enhancement by identifying those needs, clarifying the IAEA's expectations and providing a road map for them to assess themselves.

4. 26th of April this year was the 20 years anniversary of Chernobyl accident. What progress do you see after Chernobyl for safe operation of NPP in the world?

In the wake of the accident, nuclear operators in the world created a new organization, the World Association of Nuclear Operators (WANO), in order to share operational experiences and lessons learned; to cultivate a safety culture; to improve operational procedures and to pursue continuous improvement by setting safety performance goals. The information on the WANO web site tracks improvements in performance. As I mentioned in my answer to the first question, there is noticeable improvement in safety performance as a consequence of various initiatives.

As discussed in a series of reports by international experts on safety (International Nuclear Safety Advisory Group), the Chernobyl accident was the result of a deficient safety culture, as well as specific design features of the reactor.Since the accident the IAEA has stressed the need for the industry to share information, encouraged operators to learn from the experience of others, set clear safety standards, and it has assisted in upgrading safety and the reviewing operational performance.

In addition to WANO, the Convention on Nuclear Safety was developed. It is now ratified by the parliaments of all countries with nuclear power plants. In practice the Convention means that each country has to provide to the international community a report on nuclear safety and explain what has been and what is being done to improve safety in existing nuclear power plants.

However, as someone mentioned, good is not good enough.

In spite of all this, nuclear safety worldwide still faces occasional serious problems such as in Davis-Besse and Paks, as well as falsification issues due to complacency, over-reliance to contractors, organizational oversight weakness, production pressure etc.

Diligence is required to make certain that the lessons learned from Chernobyl are not forgotten.

5. What is the status, progress and future of the Agency International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)?

Director General of the IAEA said in his speech at the General Conference in 2004, "A factor key to the future of nuclear power is the degree to which advances are implemented in evolutionary and innovative reactor and fuel cycle technologies, to address safety, waste and proliferation concerns,

as well as economic competitiveness."

After almost five years of efforts, the methodology to evaluate Innovative Nuclear System and the national/regional programme in the context of safety, economics, waste, environment, infrastructure and proliferation-resistance is almost complete. The manuals for detailed evaluation of each of these elements are approaching completion.

Several assessment studies using this methodology are ongoing, for example the Joint Study (Russia, France, Japan, India, China, Republic of Korea, and Canada) on the closed fuel cycle using Fast Reactor and the French study on the transition phase between the current fleet and the Gen IV systems. The number of such assessment studies has increased to 11.

In some of these studies, the Member States are identifying needs for international collaborative activities. Consequently, the framework, option and guidelines for execution of this collaboration was discussed in April 2006 by Member States.

Against this background, the INPRO decided, in the 9th Steering Committee held in July 2006, to move to the next phase that consists of three directions of activities; further improvement of methodology, infrastructure and institutional aspects, collaborative projects.

6. What is the relationship with GIF (Generation Four International Forum), especially when INPRO is moving to collaborative projects?

The IAEA experts have been participating in activities of GIF such as Proliferation resistance WG (PR&PP WG), Risk and safety WG (RSWG) in their capacity. GIF kindly finished the peer review of INPRO evaluation methodology in January 2005.

GIF/IAEA/INPRO interface meetings are occasionally held in order to exchange information and consider possible synergy by working together. For instance, the September 2005 meeting, which involved more than 10 participants from GIF, resulted in identifying many areas for further information exchange. In particular, this meeting recognized "complementarity" of the activity: GIF focuses on Generation IV system R&D and methodology to guide its development, while INPRO focuses on three pillars: methodology, infrastructure and technology by bring technology holders and users together.

As for collaborative projects, the IAEA has a well established rules and practices such as Coordinated Research Project and Technical Cooperation projects (technology transfer) based on IAEA statute Articles III A (the IAEA is authorized to encourage and assist research on, and development and practical application of, atomic energy for peaceful uses throughout the world).

The INPRO collaborative projects include research for collection of data, code benchmarking, and method development but are not limited to them, depending on the wishes of the INPRO Members and availability of resources. Of course, the topics should not duplicate other IAEA activities and should take advantage of synergies with other international activities.

Participation of Russia and China to GIF would certainly demand clear definition/distinction especially in the Collaborative Project area between INPRO and GIF.

7. How many countries are the members of INPRO and how it is operated?

With the participation of two countries in 2005 (Ukraine and USA) and two in 2006 so far (Japan and Slovakia), INPRO members now count 26. This includes countries which do not yet have operating nuclear plants. The participation of technology users is an important element of INPRO.

My personal view is that INPRO can offer three important things to developing countries: methodology for vision and scenario assessment, support of infrastructure building and international/regional institutional arrangement and lastly, INPRO provides opportunities for joint development of Innovative Nuclear Systems.

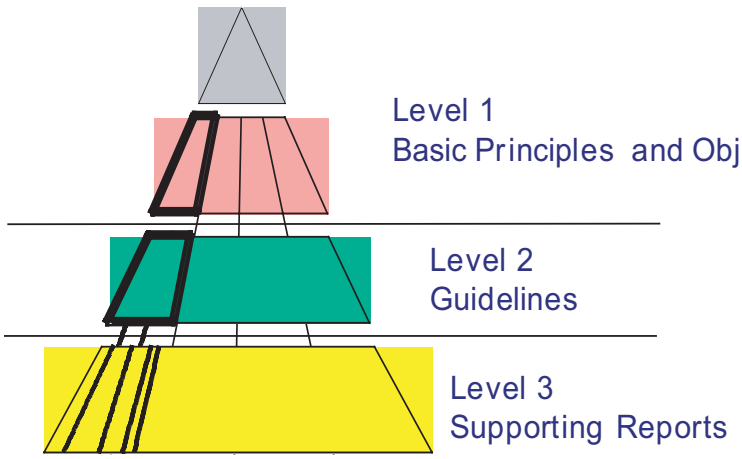
Certainly developing countries may prefer "proven" design in the deployment of their first nuclear power plant, but things may change. Their active involvement in the development may influence cutting-edge technology. One such example might be the small reactor without onsite refuelling linked by regional Fuel Cycle Centre.

The INPRO is supported mostly by Extra-budget fund. In addition, international experts, as cost free experts, provide in-kind contribution. Its activities are steered by Steering Committee by INPRO members.

Because of its wide spectrum of activity, inter-departmental experts support the day by day operation under guidance from area coordinators.

8. What are the missions of the Department of Nuclear Energy of the IAEA and where is the emphasis of its programme in the coming 5 years?

The three missions of the department are; support for the operational



Basic Principles: Manifest rationale and vision of peaceful use of nuclear energy
Objectives: High level advice on the expectations, analysis of the design and development of nuclear facilities, systems and activities etc. ("What" to achieve)
Guidelines: ("How" to achieve the objectives)

Fig-3 Hierarch of NE's documents

excellence of existing facilities, catalyzing innovation, supporting knowledge management and capacity planning.

Setting aside safety, security and safeguard, in my view, four topical areas currently deserve more emphasis as far as the programme in the NE department is concerned; support to infrastructure building, support to aging facilities in their life extension, innovation, global vision and implementation strategy on the future role of nuclear energy. Other programmes in the department would put more emphasis on the support to uranium exploration, support to energy planning and knowledge management etc.

Let me also touch upon the Nuclear Energy series document. We are continuously producing many TECDOC, TRS and others. However, there is no structure to provide consistent, systematic and effective document production by filling important gaps in a structured document system. Also the current system does not enable easy finding of documents. Improvements will be possible by providing hierarchy structure (*Fig-3*) and positioning each NE's document in the structure and by ensuring continuity of documents through established preparation and review process and renewal period.

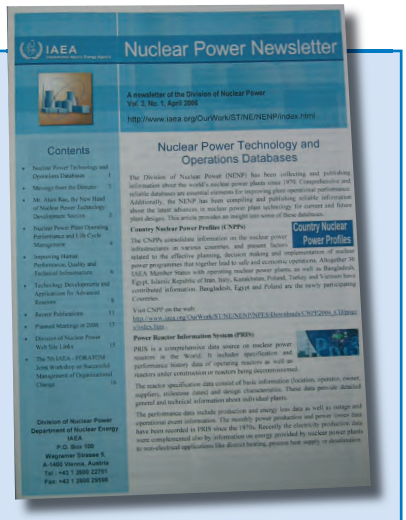
Further, an improved process, including intensive internal as well as external review, would improve the credibility and quality of technical documents. Work has started on this.

9. How are your division addressing plant life management, aging and life extension programmes?

I figure that the Member States need not only the generic guideline of the life management approach but also

- Reduced uncertainties in the prediction of component degradation,
- Improved methodology for optimization of investment (timing of refurbishment linked with power up-rating),
- Efficient techniques for inspection, maintenance and replacement.
- Besides producing guideline documents, tools or database in respect of the above, our activities also include support of the use of modern technology such as reliability centred maintenance (RCM) and condition based maintenance (CBM) for better plant life management.

"Activities also include support of the use of modern technology such as reliability centred maintenance (RCM) and condition based maintenance (CBM)."



The outputs of the Division of Nuclear Power might be consulted in the web site http://www.iaea.org/OurWork/ST/NE/NENP/index.html

Technical documents from the Agency are available from; http://www-pub.iaea.org/MTCD/publications/series1.asp

In order to make these publications widely known and to inform of our activities in a timely manner, almost two years ago the Division of Nuclear Power started sending its own Newsletter (also available on web).