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Meeting of Senior Officials on

Managing Nuclear Knowledge

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Abstracts of Keynote Papers

Present and Future Development of Nuclear Knowledge

Mr. Ch. K. Lee, INSC, Republic of Korea

Over millennia, Man has developed technology, and this technology has made possible a great increase in population, which in return finds technology indispensable. The progress in technology has been accompanied by a depletion in natural resource and pollution.

The doubling of the population required 1,650 years from the Year AD One, but now takes a mere 45 years. Consumption-based economies in modern times also mean that each person consumes ever so many things in order to live, and massive production and distribution networks lead inevitably to pollution and environmental devastation. The future of mankind is in jeopardy and nature has only a limited capacity to absorb and handle this extra burden of pollution. Fortunately, nuclear energy can be deployed to mitigate and even to reverse the global trend toward destruction of the environment. Issues are addressed under the headings of what is known, what should be done now and for the future.

Our first priority should be training of manpower to make effective use of the nuclear knowledge which is already abundantly available. Secondly we must push for research & development in all phases of the nuclear program. Our third priority must be to develop a desalination reactor and to produce cheap and abundant nuclear hydrogen and confront the environmental issue with a high-temperature reactor. IAEA's INPRO and U.S.-led Gen IV programs together with associated fuel cycle schemes must be encouraged with a view towards eventually developing economic, reliable and proliferation-resistant reactors and fuels. Finally, the nuclear community must strive to develop a commercial transmutation reactor to incinerate long-lived radioactive nuclides.

Two Perspectives for Managing Nuclear Knowledge Through Education & Training: Industry (NEI) & Utility (Exelon)

Mr. W. Naughton, NEI, USA

This presentation will provide an overview of how the U.S. nuclear industry and its largest nuclear utility are addressing the problems of Managing Nuclear Knowledge. Specifically, the impacts of declining university enrollments, closing of university departments and research reactors, aging of the workforce in both university and industry, and the needs of industry for all types of craftsmen and engineers - not just nuclear - amidst intense competition from other industries for the same personnel.

Industry responses to the problems will be discussed that include the results of an extensive survey on staffing and recruiting projections for the period 2002-2011. The lessons learned from that survey will be reviewed and an integrated plan for addressing the nuclear industry staffing pipeline will be presented. The parallel efforts of a program by the American Nuclear Society Special Committee on Workforce Issues will also be presented and discussed.

Exelon Nuclear, the largest U.S. nuclear utility with 17 operating plants, will provide its perspective on the challenges of managing nuclear knowledge in the current stable, mature U.S. nuclear market. Emphasis will be placed on the continuing consolidation and restructuring that has been ongoing since the early 1990's, the changing workforce needs, need for university nuclear department and research reactor restructuring and consolidation, and internal initiatives undertaken to ameliorate these challenges.

Finally, potential actions that may be amenable for IAEA to coordinate with all Member States will be presented for IAEA's consideration.

Preserving Skills and Expertise for Nuclear Safety
Mr. P. Storey, NII, U.K.

For many decades to come the international nuclear sector will require a wide range of highly trained, experienced and competent personnel. However, with the decline in the availability of nuclear expertise which is being felt in many countries, maintaining safety competence for both the industry and the regulator becomes a difficult challenge. Assessing the extent of the decline now and predicting what is the likely need for expertise in the future is an important task for all countries. Assessment should take account of likely scenarios for change in the nuclear industry and should aim to identify areas of expertise most likely to be at risk. International Agencies are playing a key role in raising awareness about regulatory concern and are starting to coordinate response and exchange good practice. Regulatory responsibility for preserving skills and expertise and International Agency leadership are essential for a successful outcome to the issue.

Managing Nuclear Knowledge In Developing Countries A View from Pakistan

Mr. I. Ahmad, C.E. Secretariat II, Pakistan

For the developing countries, managing nuclear knowledge requires both acquiring know-how from the developed countries as well as building and conserving their own knowledge resource. The rapid growth of information technology culture has made vast amounts of information and database universally accessible although some bars do indeed apply. The challenge, therefore, lies in having a continuous supply of different tiers of trained and competent professionals who can benefit from what is available and can carry on developing the indigenous capability.

This presentation focuses on the issues and problems faced in meeting the above challenge. Steps taken in a developing country like Pakistan to manage nuclear knowledge will be discussed. These measures include developing an interface between the universities and the industry as well as concentrating on meeting the specific infrastructure requirements. The task is, however, becoming increasingly difficult for the developing countries because of the fall out of the lack of proper growth in the nuclear industry at the global level, and the large and long-term financial commitments associated with nuclear energy which leave the entire burden of the nuclear power program development on the public sector.

Managing Nuclear Knowledge and Expertise – An Industry Perspective

Mr. Ph. Garderet, Arevagroup, France

The industrial demand for expertise and qualified personnel in nuclear sciences and technologies will obviously continue to be strong during the next decades : in all cases, a high level of competences will necessarily continue to be required to maintain high performances in operating current nuclear facilities (up to decommissioning) ; moreover, additional skills are to be engaged to conceive new projects or to propose new services for new industrial customers.

The industrial needs evidently show some quantitative or qualitative specificities according to the strategy each country has adopted in the past or is adopting now for the use of nuclear power or other nuclear technologies. But the general trends concerning the access to qualified knowledge in nuclear sciences and technologies are globally the same, so concrete actions have to be taken as soon as possible to anticipate difficult situations and overcome the problems.

In the countries where nuclear industry has been strongly developed during the past decades (for example France) the problem chiefly concerns the relative ageing of the human workforce and the ability to maintain the accumulated knowledge and replace technical expertise at the very moment when all the technological companies show a significant decline in the number of entrants in all the domain of science and engineering.

The problem is reinforced by the fact that (strictly for the same reasons) this phenomenon is observed concurrently within the research laboratories, among the staff of the safety authorities and, more generally, in all the offices engaged in the decision making process about nuclear affairs.

Part of the solution to these serious problems stands in the human resources policy that the main nuclear industries have to achieve : internal training through enterprise universities, auto-formation, tutorage of young scientists by seniors, programs of knowledge preservation, international mobility when possible.

But more active cooperation must be imagined between industry, the educational system, the - chiefly - technical universities, engineering schools, and research laboratories to promote science and technology among the public, support educational activities in the basic sciences founding nuclear activities, and anticipate by a constant recruitment policy the recurrent needs for industrial development.

The Management of Nuclear Knowledge andExpertise for Sustainable Development

Mr. W. Stumpf, Univ. of Pretoria, South Africa

Knowledge has become the key resource of most organizations in the world's globalised economy. This resource is principally people-centered and mostly requires new ways of management in an age where the mobility of knowledge workers has become very high, with typically up to 7 job changes in a life time that is the norm in the US today. To manage knowledge effectively in such an environment, however, requires a wider organizational view and the concept of *organizational knowledge,* rather than simply knowledge that is centered in individuals, needs to be addressed. Organizational knowledge is firstly made up from experience within individuals but also embodies organizational concepts, values, beliefs and "ways of working". True organizational knowledge is, therefore, shared and distributed widely within the organization.

Managing organizational knowledge effectively through the concept of Prahalad and Hamel of an "*organizational core competency*" has proven itself within many large and small organizations throughout the world as it introduces a dedicated focus within the organization. This allows the long-term investment in organizational knowledge that supports the core competency but also allows the redirection or termination of those capabilities that do not. During large-scale changes in the work environment of an organization, hard knowledge or data can be captured relatively easily but not the more nebulous "tacit learning" that is deeply embodied in the life-long experience of employees. Some of the more recent methods of attempting to capture the tacit learning within organizations are explored.

The organizational loss of knowledge in the front end nuclear fuel cycle experienced by South Africa in the early 1990s has been estimated to be about 22000 person-years of the technologically skilled nature of which 10% were considered to be in the "highly skilled" area and another 6% in the category of "core experts". Problems in preserving this pool of knowledge at that time are highlighted in the paper.

Since the middle 1990s, the Agency has redirected its technical co-operation (TC) programme towards a focused "needs driven" approach away from the former largely "technologically driven" approach. From a "before" and "after" comparison of the *strategic drivers* that impact on the preservation of nuclear knowledge for these TC projects, it is concluded that the new strategy of ensuring measurable socio-economic benefits from every TC project, is far better placed to manage the preservation of the necessary nuclear knowledge and to ensure the sustainability of these projects within the developing world.

The paper concludes with some areas that the Agency may wish to consider further in strengthening the preservation of knowledge within these TC projects to ensure their long term sustainability and maintain the flow of socio-economic benefits to the broader society within the recipient Member State.

Managing Nuclear Knowledge – A Government Perspective

Mr. A. Kakodkar, AEC, India

Nuclear science and technology has come to the present level as a result of research and development carried over several decades. Many research reactors as well as other major experimental facilities have been built around the world and major nuclear research centers have grown around such facilities. These centers have played an important role in the development, demonstration and deployment of nuclear technologies and have enabled scientific enquiry and technology development to be pursued in a synergistic manner. As a result of these efforts, a sound theoretical base, a variety of skills and several technological processes have evolved. All these together comprise nuclear knowledge, and what has been painstakingly acquired has to be preserved. Knowledge generated at research centers or laboratories has been exploited by governments for the welfare of the people and by industry for economic growth. Ensuring adequate funding for generic research has been a government responsibility, while industry has concentrated on customizing the outcome of generic research for the development of specific goods and services. During periods of growth of a given technology, R&D funding naturally takes place. However, difficulties arise during periods of stagnation and it is during such periods that governments have to step in with a long term perspective. Think tanks also have to help in identification of issues involved and provide directions for the future.

All around the world, there is a growing chorus of voices about issues related to sustainability. One has to remember that sustainability issues, while they arise as a result of economic and other evolutionary processes that come about as a result of technology, their solution also lies in technology itself. For example, application of technology to agriculture has ensured that in spite of continuous growth of population, hunger is not as prevalent as predicted. However, new sustainability issues have arisen and have to be solved. Increase in the level of greenhouse gases in the atmosphere due to the use of fossil fuels is also one such issue. It has not happened overnight, but over several decades. Indiscriminate use of plastics, increase in generation of all types of industrial wastes are some other issues. The issue of nuclear waste, however, has attracted disproportionate adverse attention in spite of the availability of technological fixes, a situation far better than many other similar issues. All these issues need to be addressed on the basis of available knowledge and continuous research. The research activity aimed at finding a long term solution for nuclear waste has been highlighted by the nuclear industry out of genuine concern for human welfare and scientific solutions now exist and what is needed is the political will to implement the scientific decisions.

Thus, it would appear that development imperatives would drive evolution and deployment of technologies. The driver could be the industry or the government depending on the gestation period involved. In either case there has to be an in-built process to assess the short and long term implications. The governments have thus to facilitate knowledge management for the purpose of sustainable development particularly when the long term issues have to be addressed.

The atomic energy programme in India has been very successful, and the two factors which have been crucial to this success are technology management within the conglomerate of institutions of the Department of Atomic Energy in India and policies followed for human

resource development. In both areas we have followed innovative approaches. For technology management, we have set up a variety of organizations to manage the complete chain involving research, development, demonstration and deployment under a single umbrella. For meeting our need of specialized manpower, we have followed the "Hire and Train" approach. Since our programme is expanding, young professionals are being inducted on a regular basis. Therefore, tacit knowledge and skills are also getting continuously passed on to the new generation of scientists and engineers. However, in the case of nations, where for various reasons young professionals are not getting attracted towards nuclear science and technology, the situation is difficult. While actions are required to ensure continuity of knowledge through induction of young people, there is also a need to document all the available knowledge base and that is where the Agency comes in. Knowledge preservation programme initiated by the Agency, organization of this meeting and the recently completed evaluation of INIS are steps in the right direction and need to be supported. We are willing to share our training facilities with other nations and we have already signed an agreement with the Agency in this regard.

Nuclear Knowledge - Present Needs and Future Perspectives
A View from Russia
Mr. E. Adamov, RDIPE, RF

1. Present situation in Nuclear Knowledge area and its application
2. Nuclear Education
3. Experimental and infrastructure of nuclear knowledge
4. Nuclear data bases
5. Nuclear software
6. The Role of the IAEA in the maintenance and development of Nuclear Knowledge.
7. Conclusions and Recommendations