



International Atomic Energy Agency

Meeting of Senior Officials on
Managing Nuclear Knowledge

17 – 19 June 2002
International Atomic Energy Agency
Vienna International Centre
Austria

Meeting Report

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Purpose and General Issues¹

In response to the recommendations of several Agency advisory committees, e.g. INSAG, SAGNE 2002, SAGNA, SAGTAC, to address issues related to nuclear knowledge management, the International Atomic Energy Agency (IAEA) convened a meeting on Managing Nuclear Knowledge on 17-19 June 2002 with senior representatives from Member States. The purpose of the meeting was to sharpen awareness and understanding of the emerging concerns about the maintenance and preservation of knowledge and expertise in nuclear science, technology and applications and to better comprehend the role of the Agency in this process.

The meeting was attended by more than 70 participants from 35 Member States and 4 international organizations, representing academic leaders, senior level executives, managers and governmental officials. A number of representatives from the Permanent Missions in Vienna were also present.

IAEA Director General Dr. Mohamed ElBaradei opened the meeting with the comment that, in his recent travels, he had frequently been hearing widespread concern about the approaching shortage of personnel in nuclear fields and it appeared that we needed to identify, and compare notes on what different countries and different organizations were doing. He posed the question, "Do we do this by accident, or is there a role for an international organization?". If we do nothing, we may be facing a situation by the end of the next decade in which the opportunity for a revival of nuclear power in terms of qualified personnel, safety, the expectations of developing countries and of our future will be lost together with the knowledge and know-how built up over successive generations.

IAEA Director General Dr. Mohamed ElBaradei invited participants to address the needs for managing nuclear knowledge, to recommend appropriate steps for the Agency and to propose concrete activities. He announced that results from this meeting would also be a topic of discussion at the Scientific Forum at the IAEA General Conference 2002.

Mr. D. Torgerson of AECL, Canada, who chaired the meeting, set the stage for the meeting in his opening remarks, stating, "Our challenge, over the next two and a half days is to better identify the scope and nature of the problem of Managing Nuclear Knowledge, to understand what Member States are doing to address this problem so we all may benefit from their experiences, and to determine how we may work together in providing an international collaborative approach."

"If we fail to transfer our accumulated base of nuclear knowledge and know-how to the next generation, then we risk losing the technology over time. The next generation must be equally capable of being prepared to accept the technology. They must know 'what', they must know 'how', and they must know 'why'."

¹ Sections on "Purpose and General Issues", "Statements and Observations", Annex 1 and Annex 2 consist of edited summaries of opening remarks, keynotes and panel discussions respectively and text from IAEA sources: The text was discussed in plenary sessions and comments by speakers, panellists and participants were integrated. The text was then edited by the IAEA. The text has not been formally agreed to by all participants and hence has a character of consolidated minutes.

A Background Paper on Managing Nuclear Knowledge was distributed to all participants in advance of the meeting and served as a basis for discussions during the meeting.

Statements and Observations

Issues and challenges related to managing nuclear knowledge were introduced in eight keynote presentations and special presentations by Member States. The presentations covered: present and future development of nuclear knowledge; education, training and research; safety perspective for managing nuclear knowledge; the perspective from developing countries; the perspective from industry; managing nuclear knowledge for sustainable development; the perspective from governments; and present needs and future perspectives for nuclear knowledge.

Details of the presentations are given in Annex 1. In these presentations, the need for increased activities in managing nuclear knowledge was emphasized. Both education and training for succession planning, as well as the preservation of knowledge for future generations were highlighted.

While challenges differ to a certain extent from Member State to Member State, and while challenges also depend on the development of the nuclear sector, it became clear that the challenge to manage and preserve nuclear knowledge is perceived as a global problem, involving diverse sectors ranging from nuclear power technology to nuclear medicine.

Regarding nuclear power and several other nuclear technologies, it was stressed that a need to manage nuclear knowledge arises even if no future growth is anticipated. The need to sustain the present level of deployment of nuclear technologies – while maintaining the present high level of safety – is in itself sufficient to justify increased attention to these issues.

In three plenary panel sessions, participants focused on the contribution and role of the Agency in this context. Details of the panel discussions are given in Annex 2. Panels discussed three separate but interlinked issues: succession planning (education and training for the next generation) and the IAEA; preservation of knowledge for future generations and the role of the IAEA; and the role of international organizations.

Participants agreed that effective and efficient solutions in the field of managing nuclear knowledge require contributions from all stakeholders – i.e. industry, governments, academia and international organizations. The role of international co-ordination and co-operation was stressed, and several proposals for Agency contributions were made and discussed.

Participants discussed a range of ideas on the role the Agency could play in managing nuclear knowledge. A list of possible activities is given in Annex 3; activities are ranked according to preferences expressed by participants².

² Each participant marked 6 priority activities in a list of 18 proposals that emerged during plenary discussions, resulting in the ranking shown in Annex 3. Annex 3 was discussed and agreed to in plenary sessions. It was edited by the IAEA.

General Recommendations³

Responding to the questions posed by the Director General, participants came to the following conclusions:

There is an immediate need to preserve existing knowledge in nuclear science and technology for peaceful applications for future generations, as it represents a valuable human capital asset. The development of an exciting vision for nuclear technology is prerequisite for attracting young scientists and professionals to seek careers in nuclear science and technology. Participants agreed that the Agency takes the lead and initiate the development of such a vision.

Irrespective of current national energy policies, the need to maintain or even enhance the nuclear knowledge base and national capability will persist. In this way, the knowledge base will be available to meet requirements for evolving policy development. Participants stressed the importance of preserving and further enhancing nuclear science and technology for socio-economic development. For nuclear science and technology to contribute to sustainable development requires knowledge and capacity on three levels: (a) basic nuclear science, (b) technology, (c) engineering and operation.

There was unanimous consensus that IAEA has an obligation to lead activities towards preservation and enhancement of nuclear knowledge by complementing, and as appropriate supplementing, activities by governments, industry, academia and international organizations. International co-operation is of vital importance. Unless action is taken now, invaluable assets in critical nuclear knowledge and capacity will soon be lost.

Participants agreed that the need to sustain the present level of deployment of nuclear technology (energy and non-energy alike) requires urgent action throughout the nuclear community and beyond. The Agency, in particular, is requested to use its potential in assisting Member States to ensure the preservation of viable nuclear education and training which is a necessary prerequisite for succession planning.

The needs may be even more pressing in Member States that consider nuclear power essential for their national sustainable development objectives and face expanding nuclear programmes.

The Agency was commended for its present activities and was strongly urged to further increase the level of attention given to knowledge preservation and enhancement activities: a list of possible activities is given in Annex 3 (attached to this report).

Participants also urged the Agency to bring the conclusions of this meeting to the attention of a wider audience, e.g., Member States' governments, the IAEA Board of Governors and the IAEA General Conference.

³ This section was discussed and agreed to in plenary sessions. It was edited by the IAEA.

Annex 1: Summary of Keynote and Member States' Statements on 17 June 2002

There were 6 keynote speakers and presentations by two Members States.

Mr. C. K. Lee, INSC, Republic of Korea focused his remarks on the rapid development of technology, particularly in most recent history, which had created environmental pollution for the world. “Nuclear energy can play a critical role in mitigating the discharge of pollution into the environment and in slowing down the depletion of natural resources. Knowledge management will be key to managing our survival in this contemporary age. By applying nuclear knowledge, we can with confidence replace fossil fuels with forms of energy which are environmentally friendly.”

Mr. W. Naughton, NEI, USA spoke of the impacts of declining university enrolments, the closing of university departments and research reactors, the ageing workforce in both university and industry, and the needs of industry for all types of craftsmen and engineers – not just nuclear – amid intense competition from other industries for the same personnel. Exelon Nuclear (the largest U.S. nuclear utility with 17 operating plants) provided its perspective on the challenges of managing nuclear knowledge in the current stable and mature U.S. nuclear market. Mr. Naughton also pointed to the need for an additional 90,000 entry-level nuclear workers in the U.S. in the next 10 years. His closing remarks were on the potential actions IAEA members could take to play a strong role in facilitating resolution of the universal issues surrounding Managing Nuclear Knowledge.

Mr. Ph. Garderet, Areva group, France talked of the growing demand for expertise and qualified personnel in nuclear sciences and technologies during the coming decades. “In countries where nuclear industry has been strongly developed during the past decades, 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.” More active cooperation should be envisaged between industry, the educational system, technical universities, engineering schools and research laboratories to promote science and technology among the public.

Mr. I. Ahmad, C.E. Secretariat II, Pakistan opened with the statement that for most of the developing countries “Nuclear know-how started declining before it had a chance to grow!” Most developing countries lacked the resources and infrastructure to support the nuclear knowledge culture even in the absence of public opposition. To develop nuclear power and nuclear industry, developing countries looked to the developed countries for technology and support, and the IAEA’s role was therefore important. Developing countries also needed competitive small and medium sized reactors and to develop and train skilled manpower to operate these plants. The more knowledge which was shared, the more valuable it would be! To ensure the preservation of knowledge, the best approach was to work for global nuclear revival.

Dr. P.D. Storey, Nuclear Safety Directorate, HSE, UK focused his remarks on the need to ensure sufficient numbers of qualified staff with appropriate education, training and retraining for all safety-related activities in or for each nuclear installation throughout its life, and for many decades to come. He pointed clearly to the international leadership responsibilities of (1) the IAEA, for its INSAG statement, and for international education and

training; (2) the OECD, for NEA's assuring nuclear safety competence and maintaining research capability, and for NDC/NSC's nuclear education and training and nuclear support excellence; and (3) the EC for European networking and European study programmes and courses. He proposed that the Agency should coordinate follow-up on recommendations made previously especially in terms of sharing good/best practice.

Mr. W. Stumpf, University of Pretoria, South Africa commented that true competitive knowledge occurred organisation-wide and should be managed as a core competence and as a strategic resource of the entire organisation. In South Africa during a fundamental strategic redirection of its nuclear programme, more than 4500 technologically skilled persons had had to be reduced from the full front end nuclear fuel cycle programme in the early 1990s, which was the equivalent of more than 22,000 person-years of specialized nuclear knowledge. Where a large scale strategic redirection in any nuclear organisation occurred, a loss in nuclear knowledge was inevitable but should be minimized. The Agency's revised "needs driven" strategy towards sustainable development through technical co-operation had made the management of the required knowledge to sustain these projects more effective. Some recommendations to strengthen this management process even further were put forward.

Mr. A. Kakodkar, AEC, India, stated that many research reactors as well as other major experimental facilities had been built around the world with major nuclear research centers growing up around such facilities. All of these research centres together constituted large repositories of nuclear knowledge, and what had been painstakingly acquired must be preserved. All around the world, there was a growing chorus of voices about issues related to sustainability. While actions were required to ensure continuity of knowledge through the induction of young people, there was also a need to document all of the available knowledge base, and the IAEA had a role to play here. Knowledge preservation programmes initiated by the Agency were steps in the right direction, and needed to be supported.

Mr. E. Adamov, RDIPE, RF provided insights into the situation in Russia. He mentioned general ageing of nuclear experts and reduced access of the educational base to field experiments even against a recent growing demand for nuclear power. He underlined the great importance and need for preservation of experimental data gained from previous experiments for benchmark processing in view of the current reduction in experimental capabilities. He mentioned that, despite the variety of databases available, there was a lack of informational systems to describe them and he recognized a need for maintaining codes at a high level through verification tests under conditions of deteriorating experimental facilities. He clearly identified the role of the Agency in the management of nuclear knowledge through the development of informational systems and coordination of international efforts to create factual data systems and experimental programmes. He stressed that, since nuclear power had only recently become a real need because of the lack of natural resources and environmental constraints, government support should be re-established for both the preservation of knowledge and further development in order to encourage the renaissance of nuclear power.

Annex 2: Summary of Statements and Observations during Panels on 18 June 2002

Panel 1 : *Succession Planning and the IAEA*

Mr. Torgerson was chairman and moderator of the panel.

Each panel member presented information on information management and succession planning relative to their country and to the international community. All participants expressed their interest in , and support for, the involvement of the IAEA in this very important endeavour.

The Chairman began the session by stating that “there appears to be three aspects of agreement this far. That is that we must preserve (1) nuclear data, (2) nuclear infrastructure, and (3) people with nuclear knowledge.” At the same time there were some differences among the countries represented, which included the fact that some were current users of nuclear technology, some only needed to maintain their current knowledge and workforce, and, thirdly, some countries were in the development stages of new applications for nuclear knowledge. It appeared there was a consensus on the need to find ways to preserve nuclear knowledge, but there was also a consensus that we needed a future vision against which to apply this preservation. He reiterated that future generations must know “what”, they must know “how”, and they must know “why.”

In the presentations and open meeting discussions, several main themes had developed that raised the question of the role of the Agency in succession planning.

Some of the discussion brought forth creative new suggestions such as a proposal for the IAEA to lead a new education system based on a network of European Universities, which would result in the granting of a European Master’s degree in Nuclear Science, and a proposal for introducing a Master’s Certification in Health Physics. In these areas, the IAEA’s role would include support for a worldwide education network, which would greatly enhance and strengthen the infrastructure for Nuclear Knowledge Management. However, it was pointed out that IAEA should accept the challenge of competitive market needs by adopting innovative methods of teaching based on partnerships with research institutes, universities and industry in choosing research and application programmes which have good chances of economic success. It should also promote international collaboration to achieve education and R&D excellence.

Additional discussions centred on the direct role of the IAEA in succession planning. It was suggested that IAEA could:

- Coordinate the needs of Member States and examine the problem from a global perspective
- Focus international attention on where resources should be deployed to ensure maintenance of the existing body of knowledge, and
- Formulate and implement specific projects to promote the transmission and sharing of this knowledge.

It was clearly identified that the IAEA should provide the forum for discussion and formulation of these needs through its established structure and policy-making organs. The Agency should also continue its efforts to create an Agency Nuclear Information Resources System.

A good example of the value of preserving nuclear knowledge was the current development of pebble bed reactors in South Africa, which had been developed and abandoned by the Germans and subsequently picked up by the South Africans.

The IAEA was also identified as a needed catalyzer to promote education programmes, to gain understanding and support of political entities for these education programmes, and to capture existing nuclear knowledge. There was a general difficulty in attracting young people into the field of nuclear engineering and physical sciences. The courses seemed too difficult, the jobs on graduation uninteresting and the pay too low; there was also view that only the “least attractive” people went into these fields. It was pointed out that “before we can educate new people into this field, we must first attract them to the field. And engineers themselves are lousy marketers!”

Finally, there was discussion and consensus that the IAEA should take a lead role in articulating why nuclear education was important and provide key statements that could be provided to country leaders and political decision makers to gain their support.

Panel 2: Preservation of Knowledge and the Role of the IAEA

The chairman and moderator, Mr. Torgerson, opened the panel.

Opening discussion was directed at the IAEA's current activities. Knowledge preservation was already recognized as being the focus of at least one study group. However, it was also pointed out that the IAEA should take a more active role in aiding Member States to capture their own information and share it with other Member States. The Agency could also facilitate more sharing of "Best Practice" between States.

It was suggested that a "new energetic and vibrant project" would capture the attention of the public and more specifically new generation students, and that the IAEA could lead in this effort. It was pointed out that information was power, knowledge sharing was powerful and knowledge *preservation* powered the future! Hence, the need for IAEA involvement. It was also noted that "Nuclear" was NOT a mature industry, but simply had the image of being old and outmoded.

Fast reactor programmes were of special concern in the preservation of documentation. There was a strong will to preserve activity and expertise in collaboration with Japan, Russia, U.S., China, Korea, and the EC countries. While France had a programme of preservation for the next 40 years, with the recent closure of FFTF in U.S., there was a real concern that knowledgeable reactor operators, management and even documentation would simply become inaccessible without the IAEA's involvement and encouragement to government entities for preservation. Authorized funding had been cut drastically at a time when staff were aging, when no new people were coming in to a field which was gradually being eliminated from the budget, and ultimately there had been no funding for preservation of the documentation. It was possible that no new fast reactor would be built within the next 25 years. Certain areas were of utmost importance: safety, materials, physics/neutronics, fuels & materials.

The panel discussion also pointed out that preserved information was worthless if there was either no-one or no way of identifying which information was valuable. Several panel members and audience comments centered on the fact that there might only be a few dozen experts left in the world in critical areas such as nuclear fuels or nuclear physics, and perhaps the IAEA could bring these few experts together with young people to record and capture this knowledge and to instill enthusiasm for it among the upcoming generation. One of the best ways of preserving knowledge was to keep advancing it.

Panel and audience members strongly encouraged the Agency to become the "portal" for access to information, to raise awareness that this knowledge existed, and then to share that knowledge with Member States. There was concern that there should be a mechanism for accessing knowledge when a particular government no longer wished to preserve its country's own information.

In closing, the panellists identified what they thought the role of the IAEA should be in this endeavour. It was to:

1. Maximize the vast knowledge data base it already possessed and to extend its networks.
2. Encourage all countries to allow access to their knowledge.

3. There should be an effort to identify “critical knowledge” and the holder and creator of the information should identify the most critical knowledge.
4. It should assemble retired or retiring experts to gather their knowledge before it is gone.
5. It should expose nuclear knowledge to young people, and
6. It should identify vibrant new projects that were important and could create a “living” industry.

Panel 3: *International Co-operation in Managing Nuclear Knowledge*

The chairman and moderator, Mr. Torgerson, opened the panel meeting.

Panel 3 consisted of representatives from the European Commission (EC), OECD/NEA, International Nuclear Societies Council and the World Nuclear Association (WNA). International co-operation could take two forms: mutual co-operation and the sharing of knowledge within the industry could prove valuable to all involved in areas such as enhanced operating performance; equally, organisations could offer their experience through the transfer of knowledge and skills to enable developing industries to progress and advance in their field. Both needed our full support.

Several international collaborative projects were currently being undertaken within the organizations represented on the panel. The ENEN (European Nuclear Engineering Network) Project, an EC programme of research and training, aimed to establish a European Masters course in Nuclear Education, through the establishment of an International University network, with a current focus on European countries. The OECD/NEA had several projects underway, which aimed to provide its members with scientific data of direct value to their current needs. The WNA announced its intention to establish a Working Group on Nuclear Skills, which aimed to identify issues of a trans-national nature through continued dialogue and partnership with the IAEA and consultation with its membership. The continued collaboration between all these organisations and the IAEA was also strongly supported.

The issue of public acceptance and how the IAEA, government and industry could address this had been continuously raised during the conference. All sectors internationally had a role to play. Misinformation relating to nuclear energy was common. Communications with the public that presented the facts about nuclear energy and raised awareness of its use as a clean energy technology were important. The role of nuclear energy in contributing to environmental protection was one that should be promoted. Raising people's awareness of nuclear energy's contributions to CO₂ emission reductions in meeting national Kyoto Protocol emission targets and its application in the production of hydrogen for use within the transportation sector could help to provide a strong image of an industry that was clean, innovative and forward-thinking. Raising awareness in the young generation of the environmental benefits and value of nuclear power as a clean energy technology with a strong vision for the future could also act as a strong driving force in attracting people into the industry.

The IAEA, although not in a position to be a public opinion changer, could act to provide credible data and information for use in these communications. This could then be accessed and utilised by the industry both for use within government and as communications material for the public in promoting nuclear energy.

Concerns over cultural changes in career development had also been attributed to the shortage of graduates entering the nuclear sector, with people no longer wishing to commit to a long-term career within one industry. Whether this was an international issue was however not clear. Clarity on this issue was needed to determine how we could market the industry and prevent talent being drawn to other sectors.

An awareness of each organisation's role and activities clearly played a part in international co-operation – ensuring effective collaboration as well as non-duplication of efforts. The proposal that two initiatives, the EC ENEN project and the proposed

International Nuclear University in Korea could be combined emphasized this. The IAEA should consider whether the proposal was viable and, if so, how it could be effectively achieved.

The awareness of the information and knowledge available within each organisation was also important to ensure that they were effectively utilised. Publications such as the booklet *Nuclear Energy and the Kyoto Protocol* by the NEA (soon to be published) and web-based resources such as the IAEA INIS database and the WNA website were valuable communication and marketing tools which the industry should utilize to the full.

In closing, the panellists identified what they thought the role of the IAEA should be in this endeavour. It was to:

1. Adopt a vision of the industry as a clean energy resource that contributes to environmental protection.
2. Encourage the young and, in particular, women to enter the industry and in particular speak out and promote the industry.
3. Facilitate the provision of information and data for use in communications in addressing the issue of public acceptance.
4. Act as a forum for the exchange of information and knowledge within international bodies, thus raising the awareness of their roles.
5. Identify projects and other areas of work where consolidation could be appropriate in the future – and develop strategies to assist this.

Annex 3: Possible activities for the Agency⁴

Six top priority activities (ranked):

- 1. Integrate existing nuclear data and information bases (in the IAEA and in Member States) in the form of an easily accessible “Nuclear Knowledge Portal”.**
- 2. *Promote networking of institutions for nuclear education and training in Member States in coordination with existing activities.***
- 3. Develop *Guidance Documents* on the preservation of nuclear knowledge.**
- 4. Implement targeted *preservation of knowledge projects*.**
- 5. *Design and implement outreach activities, which improve the general knowledge in society of the benefits of nuclear science and technology.***
- 6. *Facilitate the development of curricula for internationally accepted higher university degrees on “nuclear technology”, e.g., by networking universities.***

⁴ This section was discussed and agreed to in plenary sessions. It was edited by the IAEA.

Additional activities (ranked)

7. Provide support for the establishment of an *International Nuclear University*.
8. *Map existing* knowledge preservation *activities* in member states.
8. Support for *networking retired nuclear experts and young generation nuclear scientists and professionals*. Establish a dedicated emeritus programme for preserving the knowledge of nuclear professionals.
9. *Strengthen fellowships* and direct support for research and higher education.
9. Develop a programme focused on *attracting a new generation of students* into the nuclear area.
10. *Determine the needs and capacity* for education, training and research in Member States including advanced technology and distance learning.
10. *Integrate available Agency resources*, e.g. INIS, into a knowledge management programme.
11. Support for closer *co-operation between industry, institutions of higher education and research centres*.
12. Support existing and facilitate as appropriate new *regional centres* for education and training.
12. Increase the *accessibility* of meaningful information and knowledge by way of expert and smart systems
13. Support of *Summer Schools* (mentoring programmes).
14. Strengthen *co-operation with other UN organizations*.