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MAINTENANCE AND PRESERVATION OF KNOWLEDGE IN NUCLEAR SCIENCE AND TECHNOLOGY

Introduction

1. The maintenance and preservation of knowledge and expertise in nuclear science, technology and engineering is becoming an issue of serious concern in a number of Member States.

2. In recent years fundamental nuclear research has received less support from governments and government-sponsored Agencies than before. This broadly reflects the fact that nuclear science and technology has acquired a certain level of maturity. Consequently, many activities that once were carried out in government-sponsored agencies are now left to industry. Privatization of the electricity sector in many countries has further strengthened the role of industry and reduced involvement of governments.

3. However, the nuclear industry, at least as it relates to nuclear power, is facing an uncertain long-term future in several countries. Nuclear power generation, in particular, encounters issues of social acceptability. Political controversies, notably in Europe, have become major hurdles for its future.

4. As a result of these developments, nuclear science professionals are opting for careers elsewhere, the number of students has decreased and many university programmes in nuclear sciences and nuclear engineering have closed. Industry is challenged to maintain the required expertise for safe and competitive operations in the future.

5. The countries with large nuclear programmes will continue to require a sizeable workforce with technical skills and experience, even if there is a decision to close down the nuclear power facilities. Issues related to safety and non-proliferation will continue to require an adequate pool of nuclear knowledge.

6. While Member States are addressing the issue individually, the Agency, in the light of the above, has included a new subprogramme in the programme for 2002/2003 on Maintenance of Knowledge in Nuclear Science and Technology within the programme of Nuclear Science (Subprogramme D4).

7. The present paper is intended to give an overview of the status, to focus on issues relevant to Member States in preserving nuclear knowledge and expertise, and to seek advice on what could be done further.

Present status

1. Expertise in the Nuclear Industry

8. The United States of America (US) operates the largest nuclear power park in the world. By 2015, some 40 percent of the nuclear-powered electricity generating plants will be 40 years old. Restructuring of the electric industry is leading to consolidation in the nuclear utilities, and plants are applying for licence renewal. This requires well-qualified manpower both for operation and decommissioning. A report by the Inspector General of the US Department of Energy (DOE) points out that the Department has reduced its federal staff from 13,640 in 1995 to 10,027 in 2000 through reduction in force, buyouts and attrition. The percentage of staff eligible for retirement has grown from 6% in 1995 to 11% in 2000. In the next five years it is expected that 34% of DOE employees will become eligible for retirement. Thus the Department of Energy may face a shortage of nearly 70% in scientific and technical manpower within five years. In another study commissioned by the Nuclear Energy Institute[1,2], the following concerns were identified by the 10 participating utilities:

- The workforce is ageing and the average age has been reported to be well above 40 and some times above 50;
- There is intense competition on college campuses from many other industries vying for the same people;
- The image of the nuclear utilities is seen as not high-tech, but traditional, conservative and highly regulated; and
- There is a perception that the nuclear industry is fading - plants are shutting down and new ones are not being built.

9. Similar concerns have recently been expressed by senior executives of German utilities operating nuclear power plants, and the reduced inflow of young nuclear engineers who should take over and carry on the successful and safe operation during the remaining life time of their plants has been considered a serious problem.[3] A recent detailed analysis of the present situation in Germany, presented to the Steering Committee of the OECD/NEA, has indicated that, irrespective of the criteria contained in the decision about the termination of the use of nuclear power in Germany, competence in nuclear science and technology must be preserved for decades to come. At the same time, the number of young graduates in the nuclear technology area has dropped drastically to almost zero in 1998/1999 and a change in the trend cannot be recognized.[4]

10. In countries of Central and Eastern Europe, many of which are largely dependent on nuclear power electricity generation, reduced support for research, education and training in

the nuclear field aggravates the situation further. The IAEA meeting of Scientific Research Centres in December 1999 has presented confirmation of these processes but indicated that an in-depth analysis is needed. In the Russian Federation the number of scientists and research workers has decreased and this may negatively influence the process of knowledge succession and preservation in the nuclear field.

11. On the other hand, countries such as Japan, the Republic of Korea, China and India are enjoying for the time being sustained government support and maintain a steady or growing workforce.

2. Nuclear Education and Training

12. While the supply and demand for nuclear graduates have been reasonably well balanced in countries with large nuclear programmes, a recent OECD/NEA study [(5)] - "Nuclear Education and Training - Cause for Concern?" - involving 16 OECD member states and more than 200 professional organizations has highlighted the following major issues:

- There is a sharp decline in several countries that are largely dependent on nuclear power, although the situation differs substantially from country to country;
- A decline in spirit and enthusiasm is the general attitude towards nuclear science and technology;
- The age factor is construed as a risk in sustaining high quality nuclear expertise;
- Research facilities are ageing or closed with no replacements planned; and
- The current supply of nuclear graduates and entry-level workers in nuclear areas is decreasing and may not meet demand in a number of countries.

13. Further, most OECD countries report a decrease in the number of new graduates from nuclear-related departments of universities (courses which are devoted to, or have a large segment of, nuclear engineering, nuclear chemistry or physics). Moreover, the number of universities offering such courses has also decreased.

14. A survey[(6)] released by the Oak Ridge Institute for Science and Education (ORISE) in 2001 highlights the fact that the number of undergraduate degrees and masters enrolment in nuclear engineering in the US continues to decline by 20% and 12 % respectively . Doctoral degrees have declined from 1999 with 14% to a number of 74 – the lowest ever since 1972.

Planned Agency Activities

15. Enhancing the role of nuclear science and technology requires the long-term commitment of all stakeholders, public and private, through appropriate and timely investment in human factor development.

16. The continued operation of the present nuclear facilities, the expected increase of activities due to life extension of existing nuclear power plants, their decommissioning and safe management of the nuclear waste, and new nuclear plants envisaged, necessitate a steady supply of qualified manpower.

17. Recently both the International Nuclear Safety Advisory Group (INSAG) and the Standing Advisory Group on Nuclear Energy (SAGNE) have concluded that it is expected that demand for nuclear expertise and qualified manpower will continue for many decades, whatever strategy each country adopts for the use of nuclear power or other nuclear technologies and applications.

18. The passing on of nuclear experience is becoming an issue for nuclear development in many countries with mature nuclear programmes. The problem has not been analyzed in depth and may appear to be much more complicated in countries which do not have large programmes for utilization of nuclear energy and therefore are not prepared to commit substantial governmental resources to this area. In future, this may hinder the capacity of Member States not only in the development or closure of their nuclear power programmes but also in other relevant areas such as non-proliferation, radiation protection, nuclear medicine, application of isotope and radiation techniques, etc.

19. For the 2002/2003 biennium, *Maintenance of Knowledge in Nuclear Science and Technology* has been included as a separate subprogramme (D4), within the programme of Nuclear Science, based on the original proposal in GOV/2001/1 and subsequent comments from the Member States. It encompasses three major areas of knowledge maintenance: policy and analysis, training and education, and knowledge management and preservation. Within the planned activities the Secretariat will prepare:

a) An in-depth analysis of the issues of knowledge maintenance and preservation using a regional approach and including all relevant regions and Member States.

b) A more efficient and closer cooperation will be established between the IAEA and ICTP in Trieste, creating better opportunities for nuclear knowledge enhancement, especially in the developing countries and producing a feasibility study for an international school in nuclear science and technology.

c) Review reports and databases on properties of irradiated graphite, thermophysical properties of materials for light and heavy water reactors. The activities within the subprogramme have also been discussed during the recent annual co-ordination meeting with OECD/NEA.

20. Furthermore, the Republic of Korea will be hosting the Second Youth Nuclear Congress in 2002, which is expected to serve as a forum for the young generation to exchange views on the importance of nuclear energy.

21. The in-depth analysis that the Agency proposes to make would cover the scope of the existing problem in knowledge maintenance and preservation in nuclear science and technology in Member States, and actions that Member States may be taking or propose to

take in addressing this problem. As part of this analysis the question whether governments see a role for themselves or whether they perceive the issue as something to be dealt with by the market would be discussed. The Agency would like to obtain information and guidance from the Member States on these issues and also on what other activities it could implement in addition to what has been presently planned under the subprogramme D4.

22. For the above purpose, the Agency proposes to convene a meeting of experts from interested Member States in the second half of 2002 with a view to sharing experience and information.

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