Report to the 48th Regular Session of the IAEA General Conference from the 7th Scientific Forum

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Mr. President,

As a Chairman, it is my privilege and duty to report to you and the Plenary the main points from the presentations and debates of the 7th Scientific Forum organized during the 48th regular session of the IAEA General Conference. This meeting took place on 21-22 September 2004 in Vienna, in an excellent and constructive spirit under the general title of "Nuclear Fuel Cycle Issues and Challenges". It gathered about 180 participants. The three sessions focused on: Advanced Fuel Cycles and Reactor Concepts; Waste and Spent Fuel Management Issues; and Research Reactor Fuel Cycle and Related Issues. All together, 12 detailed presentations were made by leading experts, followed by panellists' comments and discussion with participants.

Before presenting a short report on the points related to the three sessions, let me share with you some general comments:

After years of large R & D efforts in several countries, we presently have a wealth of important scientific results offering answers to a range of issues related to reactors, fuels and nuclear material cycles. New important results are expected to come in the next five/ten years in the considered fields.

We are now moving towards large-scale demonstrations of technologies which could give us an incentive to consider new R & D programs for fully satisfying economical, safety, reliability and non-proliferation expectations.

Due to the present world-wide energy and security context, the next years and decades will see the need for important decisions regarding the building of new power plants, the life extension of the present ones, the decommissioning of reactors as well as the

commencement of long term waste disposal projects. All these topics require firm scientific basis, which have to be shared by the public opinion as well as by the political decision makers. There is a great need to communicate on the scientific and technological achievements if we want to gain the agreement of the public.

Our discussions in the Forum revealed that there is no unique way to deal with these issues; diversity has to be fully accepted as far as we agree on the fundamental principles of safety, and environmental and health requirements. We have to set some R & D programs accordingly and work towards international cooperation and discussions to further facilitate the decision process.

Let me now turn to the discussions that took place in the Forum.

In an introductory stimulating presentation, the interest for sub-critical reactors with accelerator driven systems, from the safety point of view, was emphasized. The thorium cycle for minimizing the minor actinide problems associated with the uranium cycle was also advocated. The presentation also highlighted the need to work on highly innovative ideas to generate electricity without any radioactivity by using inertial nuclear fusion involving protons, and boron or lithium.

In Session 1, the importance of optimising in a coherent and global way the nuclear fuel cycle with respect to economics, proliferation resistance, safety and environmental aspects was emphasized. In this connection, the advanced aqueous processing of spent fuel and the emerging dry pyrochemical processes involving molten salt and electro refining were highlighted. The importance of the efficient use of uranium in fast breeder reactors was also stressed.

A survey of evolutionary and innovative reactors and fuel cycles was presented. A comprehensive review of advanced water-cooled, gas cooled, and liquid metal cooled reactors, was provided highlighting their design and operational features. The importance of international initiatives such as INPRO and GIF was emphasized in this context to optimise the large R & D efforts required.

There was emphasis on multi-recycling of plutonium and minor actinides in fast reactors, to produce additional energy from fissioning all the actinides. It was mentioned that there is a need for progressive changes in the fuel cycles from plutonium recycling in LWRs to multiple plutonium recycling in fast reactors in a phased manner over the next hundred years, for optimal utilization of uranium resources and burning of all the actinides.

The R&D needs for innovative reactor and fuel cycle technologies were discussed highlighting the Indian experience of its three-stage nuclear power programme combining pressurized heavy water reactors, fast reactors and thorium-232/uranium 233 breeders.

The Advanced Fuel Cycle Initiative (AFCI), which is designed to pave the way for an expanded role of nuclear energy in the USA was presented. AFCI is considering the technical and economic viability of four fuel cycle options, including the open cycle option, recycling in thermal reactors, recycling in thermal and fast reactors, and multiple recycling in fast reactors.

The panel discussion centered on the real need for accelerator driven systems (ADS) and FBR for waste minimization, and utilization of research reactors for development of advanced fuels and materials for innovative reactors. The panel explained the technical reasons for ADS introduction and confirmed its potential, but not yet demonstrated, role for transmutation and energy production.

Regarding the question on the introduction of innovative nuclear energy systems in developing countries, the panel pointed out that developing countries have the highest energy demand in the foreseeable future. Nuclear energy could cater to this demand. In particular, innovative reactor systems in the small and medium size category with inherent safety features and enhanced proliferation resistance are seen as a future potential source of energy in these countries.

At the end of the session there was a broadly shared view among the participants that nuclear energy as an emission free energy source is indispensable for sustainable

development. The continuous research and development in support of innovative reactors and fuel cycles is crucial. The panel also confirmed the need for research reactors as an important tool for development of innovative reactor systems. In this respect, the closure of the fuel cycle with fast reactors was highlighted.

Session 2 on waste and spent fuel management noted that the growth of nuclear power, while providing many benefits, has also resulted in an increasing global challenge over safe waste and spent fuel management. Over the past fifty years, the world has come to better understand the strong interplay between all elements of the nuclear fuel cycle, global economics and security. The nuclear fuel cycle is no longer managed as a simple sequence of technological, economic and political challenges. Rather it must be managed as a system of strongly related issues. Waste and spent fuel management cannot be relegated to the back-end of the fuel cycle as only a storage or disposal issue. There exists a wealth of success and experience with waste and spent fuel management that can be forged together to mitigate these global challenges in the future.

The participants of this session reviewed the R & D results and the experience to date, in some specific countries like Russian Federation, USA and France for instance, including approaches from direct disposal to the closed cycle. Regarding the latter, reprocessing of irradiated power reactor fuel was noted to be a mature industrial technology. Experience to date has demonstrated that reprocessing can be compatible with security and non-proliferation requirements. There has also been a continuing reduction in the volume of waste arising from reprocessing. This trend will continue with the implementation of improved technology and operating practices. R&D programmes to study the partitioning and transmutation of environmentally significant radionuclides are being pursued to further assess potential paths to enhancing the effectiveness of waste minimization programmes.

The session also noted that safe and robust interim storage technologies are available to provide system flexibility while addressing longer term waste and spent fuel management options and issues. Regarding direct disposal, session 2 participants described significant progress to date. The majority of technological issues were noted to have been

satisfactorily addressed, but ethical and social issues, remain to be addressed appropriately in some countries.

The discussions centered on the issues regarding reprocessing to preclude the need for repositories and the question of relative economics associated with the fuel cycles. The consensus among the participants was that geological disposal remains an ultimate requirement for the open as well as the closed cycle. In the discussion regarding national and multinational repositories, it was noted that it would be desirable to have operating national repositories and to further public acceptance and facilitate progress on multinational geological repositories.

Session 3 dealt with several aspects of the research reactor fuel cycle from the development and qualification of high density low enriched uranium (LEU) fuels as replacements for highly enriched uranium (HEU) fuels, through utilization, interim spent fuel management, reactor refurbishment and ultimate decommissioning.

The extensive development work to increase the uranium loading in LEU fuels and the substantial success achieved so far were reported. Also, work is in progress for development of LEU targets for fission Mo99 production. It is not expected that qualified U-Mo fuels will become available before the year 2010. In this context, the extension of the United States foreign research reactor spent fuel return program would be welcome.

While research reactors will continue to play a crucial role in nuclear science and technology it is important to ensure operational ability in terms of technical and financial resources, meeting the current standards of nuclear and conventional safety, and other aspects related to physical security, public acceptance and environmental responsibility. The technical aspects that need to be addressed include the capability for safe spent fuel management and storage, reactor refurbishment when required and the eventual decontamination and decommissioning of the facility.

For extended interim storage of aluminium-clad spent fuel, a semi-dry storage technique developed and implemented at the Budapest research reactor institute was discussed.

Irradiated fuel was encapsulated in sealed tubes filled with dry nitrogen and turned to the water storage pool. This is expected to prevent further corrosion of the irradiated fuel and hence can be used for storing spent fuel over extended periods.

Various aspects of decommissioning of research reactors were presented wherein it was highlighted that early development of a decommissioning strategy is highly beneficial. It was also underlined that a cooling-off period after the final shutdown of the reactor can be highly beneficial, not only because of the decay in radioactivity, but in the progressive availability of newly developed technologies for decommissioning. Problems of dealing with stakeholders, funding issues and waste management associated with the decommissioning of a low power research reactor were also presented and discussed.

It was stated that new research reactors would be required to investigate and develop the advanced fuel and core materials for many of the proposed innovative power reactor concepts. It was stressed that this reactor may have to be powered with HEU or plutonium fuels to investigate the conditions that will prevail in fast reactors.

Let me now conclude. The scientific and industrial communities greatly appreciate the IAEA initiative to organize this Scientific Forum on Nuclear Fuel Cycle Issues and Challenges. It allowed very fruitful discussions and provided opportunities for enhancing further cooperation involving the national programs. The meeting showed that large progresses have been made, but difficult issues still remain open. Therefore, it is important for all interested countries to carry on with ambitious R & D programs in due time in order to prepare for the future.