



*Nuclear Technology: The Role of the IAEA*

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The International Atomic Energy Agency (IAEA) was established 41 years ago with a mandate to co-ordinate international co-operation for the regulation and use of a nascent and unique technology that carried hopes and apprehensions. Today, nuclear technology is making a substantial contribution to sustainable development across many sectors, including energy, health, agriculture and hydrology. Nuclear power currently accounts for some 17 percent of world electricity supply and, as the papers to be presented to this Conference will undoubtedly show, we have clearly not yet reached the full potential of nuclear science and technology.

But as we approach the new millennium, the role of nuclear energy is under challenge. In many countries it faces active public opposition on the grounds of safety of operations and of disposal of radioactive waste. Globally, in an increasingly competitive and deregulated energy market, the industry is challenged to demonstrate and improve the cost-effectiveness of nuclear power generation. And the recent, deeply regrettable, nuclear tests by India and Pakistan have again underscored the destructive potential of nuclear energy - and remind us of the need to breathe new life into international and regional non-proliferation and nuclear disarmament efforts.

It is my purpose today to outline the role of the IAEA in assisting its Member States to meet the challenges facing the use of nuclear technology. The subject of this conference is particularly relevant: technological and scientific research and development will have a major impact on the economic, environmental and strategic context in which Governments, energy

utilities and civil society at large make their decisions on the future use of nuclear energy. But this requires a two-way process - the scientists and the technologists must also understand the overall context in which these decisions will be made in order to plan and design optimum solutions for the needs of the future.

### **The IAEA**

The IAEA Statute outlines the twin objectives of the Agency: to seek to enlarge the contribution of atomic energy to peace and development and to ensure, so far as it is able, that atomic energy is used within a sound framework, peacefully and safely. The two objectives are interdependent. The twin role of the IAEA is often misunderstood as seemingly contradictory because it simultaneously involves promotion and regulation. However, the Agency was never intended to promote nuclear energy in any commercial sense or to be a partisan organization. Its role is to be an objective and scientifically credible institution that serves as a centre for objective analysis, expert advice, standard setting, technology transfer and credible oversight and verification.

The mandate of the Agency involves five inter-related tasks. These are:

- a) to act as a catalyst for the scientific community and as a hub for state-of-the-art technology;
  - b) to act as a centre for the transfer of nuclear technologies so as to ensure their accessibility to Member States in general, and to developing countries in particular;
  - c) to assist Member States to make informed and appropriate choices concerning the energy mix by conducting comparative assessments of nuclear and other technologies;
  - d) to strive for the highest level of safety in all areas of the use of nuclear energy;
- and

- e) to assure, through its verification system, that pledges to use nuclear energy exclusively for peaceful purposes are fulfilled - that is, the role of “nuclear watchdog”.

While the priorities between these tasks change according to the needs of our Member States, all five tasks are pursued simultaneously. And all of them have direct relevance to the work you are undertaking.

### **Science and Technology**

An integral part of the initiative to establish the IAEA was to encourage and assist international collaborative research, development and the practical application of atomic energy for peaceful uses. There were two primary motivations for this. First, nuclear technology was new and largely unexplored, it was expensive and it was dangerous if not handled properly. It made good sense to seek the widest possible international collaboration to ensure its safe, efficient and effective use. Second, as was reaffirmed in 1970 in the Treaty on the Non Proliferation of Nuclear Weapons (NPT), it was of fundamental importance to ensure that States which forswore the development of nuclear weapons programmes would have access to the full benefits of peaceful applications of nuclear technology and be entitled to participate in the fullest possible exchange of scientific information and co-operation in the development of peaceful nuclear applications.

The Agency was thus given the role to disseminate scientific information, to produce technical documents and guidelines, to facilitate research and to assist Member States in the appropriate peaceful use of nuclear technology. Through these activities the Agency has become a major nuclear scientific publishing house and an internationally recognized centre for information exchange. Through mechanisms such as Co-ordinated Research Programmes (CRPs) the Agency assists Member States, particularly developing countries, to research, adapt and apply latest scientific developments. To ensure the relevance and timeliness of our activities in this rapidly changing area, and to ensure effective collaboration within the international system, the Agency relies on several advisory groups comprising leading representatives of national programmes and international organizations.

Global investment in support of nuclear power plant technology development runs to some \$2 billion annually. The Agency is used as a channel for sharing and comparing the experience gained. With respect to reactor technology, the Agency has established four International Working Groups (IWG), one for each major reactor line currently under development (Fast Reactors, Gas Cooled Reactors, Light Water Reactors and Heavy Water Reactors). These meet regularly to exchange scientific and technical information about national programmes, trends in safety and user requirements, the impact of safety objectives on plant design, and the co-ordination of research programmes on advanced reactor technology.

The Agency's programme on non-electrical applications of nuclear power focuses mainly on nuclear desalination, on which we are advised by the recently established International Nuclear Desalination Advisory Group (INDAG), and on developments with respect to Small and Medium Sized Reactors (SMRs), which are also of interest for electricity generation in remote areas or in countries with limited electricity grids. The Agency's SMR programme focuses on evaluating designs and providing Member States with information on a broader choice of reactor options to meet specific needs. Recent work includes preparation of a user requirements manual particularly for developing countries, evaluation of SMRs for co-generation applications, analysis of the economic and technical capabilities of the high temperature Gas Cooled Reactor, analysis of possible civilian applications of nuclear reactors previously developed for military purposes and the development of simulation tools to compare response characteristics of plant designs.

In the area of emerging nuclear energy systems, such as accelerator driven sub-critical systems and the utilization of Thorium fuel, the Agency is providing a forum for the review of programmes and projects in Member States. I would also mention the Agency's long-standing facilitation of nuclear fusion research through disseminating scientific information, organizing international conferences such as the Fusion Energy Conferences, publishing the ITER (International Thermonuclear Experimental Reactor) newsletter and conducting a range of workshops, Co-ordinated Research and Technical Co-operation programmes.

### **Technology Transfer**

The transfer of technology, bearing in mind the special needs of developing countries, is a key element in the Agency's mandate. One vehicle for this is the Technical Co-operation

programme, which amounts to some \$80 million this year. Through this programme, the Agency contributes to the objective of global sustainable development by helping developing countries address priority needs with nuclear techniques which offer unique or significant comparative advantage to other techniques. But, like the Agency's work in science and technology, the technical co-operation programme also has a deeper dimension. Support for technology transfer, fully safeguarded, is an essential part of support for the international consensus relating to the exclusively peaceful use of nuclear energy embodied in the IAEA Statute and the NPT.

The Agency has a broad range of programmes and partners working in areas as diverse as eradication of tsetse fly in several African countries, geothermal energy development in Latin America, child nutrition in Asia. In the Middle East, an Agency project on Isotope Hydrology Techniques in Water Resources Management has achieved good results in mapping renewable and non-renewable groundwater in regional aquifers. Field trials in Syria have demonstrated a saving of 36 percent in water use for cotton crops in a regional project on water balance and the application of fertiliser in irrigation. And substantial progress has been made in establishing projects in Israel and Jordan to control the Mediterranean Fruit Fly using Sterile Insect Techniques developed in Agency laboratories. These "nuclear" activities constitute a substantial contribution to global sustainable development - they deserve more attention and acknowledgement.

### **Energy Options and the Environment: Comparative Assessment**

With varying degrees of urgency, both developed and developing countries are being faced with major energy choices. On the one hand, recent studies project energy demand increases of between 50 percent in a low economic growth scenario to more than 250 percent for the high growth scenario by the year 2050. These demands are mostly driven by growing populations and growing economies in the developing world.

On the other hand, the Intergovernmental Panel on Climate Change (IPCC) has reported that the atmospheric CO<sub>2</sub> concentration has risen from pre-industrialization levels of 280 parts per million (ppm) to some 360 ppm in 1995, and will reach 700 ppm in 2100 in the mid-range emission scenario. Global energy services account for more than half of manmade greenhouse gases (GHG) emissions. If present GHG emissions trends continue, the IPCC has

warned of the potential for global climate disruption, including increases in surface temperature of between 1 to 3.5 °C and a rise in sea levels of between 15-95 cm.

These global environmental considerations underlie the discussions within the United Nations Framework Convention on Climate Change (UNFCCC) most recently held in Kyoto last December. The global challenge is to develop strategies that foster a sustainable energy future that will be less dependent on fossil sources. Nuclear power is already a mature and readily available technology for cost effective mitigation of GHG over the long term and presently accounts for the avoidance of about eight percent of global carbon emissions. While the short term outlook is for continued high dependence on fossil fuels and greater GHG emissions, the energy choices for the future will need to take account of global and national targets and timetables for reducing carbon dioxide emissions.

Nuclear power alone cannot ensure secure and sustainable energy supply worldwide, nor can it be considered as the only means of reducing GHGs. But, together with renewable energy sources, improved fossil fuel conversion, and efficiency improvements throughout the energy system - all of which are important - nuclear power could continue to be a key component of many national energy strategies for environmental improvement and mitigation of climate change.

The decision whether to use nuclear power is a national decision. However, the expertise of the IAEA has been sought by Member States to assist them in making informed choices with regard to the energy mix they pursue. Since 1992, the Agency has worked with eight other major international organizations on the DECADES project (Databases and Methodologies for Comparative Assessment of Different Energy Sources for Electricity Generation) to enhance databases and methodologies for comparative assessment of different energy sources and conversion technologies. The DECADES project addresses all stages of the energy chain from energy source extraction to electricity services and waste disposal. The analysis includes energy demand and supply options, economic analysis, health and environmental impact and risks of energy systems, and sustainable energy development. This methodological framework is being used by some 35 Member States to conduct their own independent energy options analyses in a transparent manner.

## **Safety and Radioactive Waste Disposal**

Concern over GHG emissions provides incentive for a fresh look at nuclear power generation. However, in many countries this incentive is counter-balanced by public concern over the operational safety of nuclear power plants and the safe and permanent disposal of radioactive wastes. This has important, if not determining, implications for political decision makers choosing between different energy options, and for the willingness of financial institutions to provide the relatively large capital amounts required for new long-term investments. In this sense, the most serious challenge to the future of nuclear power is to increase the degree of public trust in its use. In effect, this means a demonstrated record of operational safety of all nuclear power plants and the satisfactory resolution of issues concerning the final disposal of high level radioactive waste.

The responsibility for nuclear safety lies primarily with national Governments. For very sound considerations, including the potential cross-border effects of a nuclear accident, Governments have recognized the benefits of international co-operation in the safe utilization of this complex and sophisticated technology. The IAEA plays a fundamental role through three complementary activities: the development of legally binding international agreements and the servicing of their implementation; the establishment of a comprehensive corpus of non-binding safety standards; and the provision of assistance in the application of those standards through activities which include safety services, training, fostering scientific research, technical co-operation and information exchange.

Since the Three Mile Island and Chernobyl accidents, the international community has taken major steps towards a comprehensive, legally binding nuclear safety regime. Several important new international conventions have been adopted to establish harmonized minimum safety standards in all countries and to ensure adequate compensation in the event of a nuclear accident. Two instruments of particular relevance are the Convention on Nuclear Safety, which deals with the safety of civil land-based nuclear power plants, and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management which applies to the safety of spent fuel and radioactive waste managed within civilian programmes. The priority now is to sustain the momentum for more States to ratify and implement these conventions.

But we also need to be proactive in identifying areas in which the international community as a whole would benefit from binding norms. When it comes to nuclear safety, hindsight is not an adequate teacher. Research reactors, fuel cycle facilities, transport of nuclear material and radiation protection are areas which IAEA Member States and the Secretariat are examining with a view to determining the benefits of establishing binding international standards.

With respect to non-binding safety standards, a high priority for the Agency over the next biennium is to complete a major revision of the Agency's Safety Standards and Guides covering the four areas of nuclear, radiation, waste, and transport safety to ensure that the entire body of standards is comprehensive, coherent and consistent. This work is being coordinated by an Advisory Commission on Safety Standards comprising senior government officials which overviews the work of four specialist advisory bodies.

It is equally important to ensure that binding norms and standards are implemented. We are making strenuous efforts to ensure that the extensive range of practical assistance services provided by the Agency for on-site peer review and expert advice are used more extensively and where most needed. This is the most practical way for safety culture to penetrate borders. The Agency's global Nuclear Safety Review for 1997 shows an overall positive trend, but it also identifies some areas where there is significant room for improvement. The Agency is developing a new strategy that aims to enhance safety. This strategy includes the development of National Safety Profiles, a more active dialogue with relevant Member States and strengthening the Agency's interaction with the nuclear safety community - regulators and operators - governmental and non-governmental.

The fact is that a strong and effective safety culture, effective national control of all radioactive sources and well focused research and development programmes for safer and more efficient nuclear technology are building blocks for public confidence and for operational efficiency and economy.

In this context, the issue of radioactive waste management is particularly high profile and urgent. The volume of wastes being generated from the application of nuclear techniques in medicine, agriculture and industry is increasing rapidly. The forthcoming decommissioning of a number of power and research reactors will add substantial quantities of both high and low level wastes to this volume. I believe we have come to the time when action is required.

The nuclear community must not only say that radioactive wastes can be safely disposed, but the political decisions must be taken to demonstrate this by proper identification and conditioning of radioactive wastes and building final repositories.

### **Verification and Safeguards**

Public confidence depends not only on the safe use of nuclear energy but also on its peaceful use. This brings me to the role of the IAEA to assure, through safeguards, that pledges to use nuclear energy exclusively for peaceful purposes are fulfilled. In 1997, over 180 States were subject to IAEA comprehensive safeguards. Safeguards were applied to over 900 facilities involving more than 10,000 days of inspection.

For much of its existence, the full potential of the IAEA as the global instrument for nuclear safeguards was restricted to a system that focused primarily on nuclear material and activities declared by the State. The shortcomings of this system pointed out in Iraq, the Democratic Peoples Republic of Korea (DPRK), and reinforced in the very different case of South Africa, made it clear that effective safeguards must cover not only declared nuclear activities but also possible undeclared activities.

The experience in each of these areas led the international community to show the political will to enable the IAEA to develop a more effective safeguards system that is designed to provide assurance not only about nuclear activities declared by a State (correctness), but also about the absence of undeclared activities (completeness). To do this, the system needed to move beyond its original focus on nuclear material accountancy - essentially an audit system designed to keep track of material declared to the Agency - to a system which affords the Agency a vantage point from which to develop a comprehensive picture of all nuclear activities to detect any inconsistency or anomaly, which suggests that the information provided by a State may not be complete.

In May last year, the IAEA Board of Governors approved a Model Additional Protocol which provides the necessary legal authority for implementing new measures that will significantly strengthen the safeguards system. On the basis of the model, States are invited to conclude a Protocol additional to their existing safeguards agreement. Nine States have signed Protocols, a further 17 Protocols (including key countries and groups such as the members of the

European Union, Canada and the United States) have been approved by the Board of Governors and one Protocol has entered into force. The sooner Additional Protocols are completed and implementation begins, the sooner we will accumulate the practical experience necessary to be able to adjust and better focus our activities to achieve greater efficiency and greater effectiveness of the safeguards assurance. The conclusion of Additional Protocols by all States by the year 2000 is not an unrealistic goal.

Strengthening the effectiveness of the safeguards system has three major components: more information, more access and greater use of appropriate technology. Under the strengthened system, States are required to provide more detailed information covering all aspects of their nuclear and nuclear-related activities. Through this greater transparency, and through strengthened analytic techniques, the Agency is able to form a comprehensive picture of a State's nuclear programme.

The system provides for substantially broader access for inspectors. The essence is: trust, but verify. The State is required to provide access to all locations that are, or could be, engaged in nuclear fuel cycle related activities and, if this is not possible, to make every reasonable effort to satisfy Agency requirements without delay through other means. Of special importance are the modalities for greater use of unannounced and short notice inspections.

With respect to technology, the Agency has the right to collect environmental samples anywhere it has a right of access. Results to date have demonstrated that such techniques are powerful tools for detecting undeclared activities and for providing unambiguous information about the full range of past and current nuclear activities at a specific site. The Agency is also preparing for extensive use of remote monitoring technology transmitting to IAEA headquarters in near-real time images and results appropriately authenticated and encrypted.

This more finely meshed system being introduced can raise substantially the level of assurance, but it must be recognized that even with full implementation no system of verification can ever provide 100 percent assurance. Some uncertainty is inevitable in any country-wide technical system that aims to prove the negative, i.e. prove the absence of concealable objects or activities.

But nuclear safeguards must be seen as only one part of the overall non proliferation regime. The effectiveness of safeguards is a critical element in establishing the degree of assurance that a State is not cheating on its undertakings. But it is not the only element. The level of assurance derived from safeguards must be supplemented and reinforced by other mutually reinforcing components of the non proliferation regime and particularly political elements. These include export-import controls, regional and global security arrangements and the engagement of the Security Council as appropriate. Recent experience has shown again that all these elements need to work together for the non-proliferation regime to be fully effective.

The end of the cold war has brought profound changes but, with respect to nuclear non-proliferation, as we have seen in the case of the recent tests by India and Pakistan, it is a mixed picture of global hopes; regional tensions. On the one hand, the declared Nuclear-Weapon States have taken steps in nuclear arms reduction, several States have dismantled, rolled back or foreclosed their nuclear weapons option and there have been important developments in strengthening the safeguards system. On the other, in key areas of high tension including the Middle East and South Asia, regional accommodations have not yet been reached to enable the full application of the non-proliferation regime.

In the aftermath of the recent nuclear tests by India and Pakistan, more than at any time before, we need - all of us - to reaffirm the course of action for non-proliferation and nuclear disarmament that has been painstakingly established over a quarter of a century. This means insisting that nuclear tests are a relic of the past; that the nuclear club has shut its doors forever - it already has five members too many; and that the commitment to negotiate nuclear disarmament entails commitment to precise results.

The recent Indian and Pakistani nuclear tests have underlined two realities: first, that the possession of nuclear weapons does not provide security - on the contrary, it is an encouragement to escalation, proliferation and insecurity. Second, that security problems which are left to fester unattended eventually erupt with incalculable consequences. Clearly, we should continue to control actively the spread of weapons-relevant equipment, material and technology. But unfortunately, the "knowledge" genie cannot be put back into the bottle, and hence we must increase our focus on the driving forces behind the acquisition of nuclear weapons, namely regional and global instabilities. This means working not only on

eliminating weapons, but equally striving to remove the incentives to acquiring nuclear weapons by redoubling our efforts to find solutions to real and perceived insecurities.

### **Middle East NWFZ**

This leads me directly to comment on the IAEA role with respect to application of safeguards to all nuclear activities in the Middle East and the establishment of a Nuclear Weapons Free Zone (NWFZ) in that region. In accordance with successive IAEA General Conference resolutions, the Director General of the IAEA has been requested to consult with the States of the Middle East "...to facilitate the early application of full-scope Agency safeguards to all nuclear activities in the region as relevant to the preparation of model agreements, as a necessary step towards the establishment of a NWFZ in the region".

Consultations with States in the region have been ongoing since 1992. At the conceptual level a number of points have emerged, including: 1) that it would be desirable for Agency safeguards to apply to all nuclear activities in the Middle East; 2) that the establishment of a NWFZ with appropriate verification arrangements would be an important step in enhancing security and creating confidence; and, 3) that a verification system for a NWFZ would most likely need to be comprehensive and intrusive to be able to deal with the legacy of wars and distrust that exists in the region, and would most likely benefit from a system of mutual verification by the Parties in addition to global verification by the IAEA.

But on the practical level, opinions continue to differ on key issues of timing, i.e. whether the application of safeguards to all nuclear facilities should take place as a confidence building step that would contribute to the establishment of a NWFZ and to the attainment of a peaceful settlement, or whether priority should be given to the establishment of comprehensive peace in the region which could later be followed by the conclusion of a NWFZ agreement in the Middle East, of which safeguards application would be an integral part.

These are issues which only the parties themselves can agree upon through a process of consultation and discussion. Through consultations with the States in the region and, as requested, through events such as technical workshops, the Agency seeks to contribute to this process by familiarizing government officials with safeguards concepts, tools and possible modalities in order to increase their choices of options. We have no mandate to impose

verification agreements on any Party or to decide for the Parties the material obligations of a NWFZ, and we cannot produce any meaningful work on model agreements until there is greater clarity from the States concerned as to the material obligations to be verified. But we do have considerable experience in operating verification of the respect for many such agreements and zones, which could vary in content and scope.

The IAEA's role is to show that verification tools and mechanisms can be tailored to meet the interests and needs of States in the region and thus facilitate their efforts to reach acceptable security arrangements. This is an important contribution we can make to the process of establishing peace and security in the Middle East. I would ask the States of the Middle East to work with us to this end.

## **Conclusion**

Three decades ago, nuclear energy was hailed as the energy of the future. Today, its growth is stagnant in the United States and Western Europe, but it is expanding in Asia and Eastern Europe. Global environmental considerations such as those discussed at the Kyoto Conference should encourage a fresh look at nuclear energy's potential contribution to combat the greenhouse effect. But the extent to which objective consideration will be given to the positive contribution of nuclear energy to human welfare and sustainable development depends on ensuring its peaceful and safe use and its competitiveness in the market place. I must emphasize that these are not competing objectives - there is no trade-off between peace, safety and economics. All must be pursued equally.

The purpose of this conference is to share knowledge, experience and ideas on emerging nuclear energy systems. From the perspective of the IAEA, I welcome and encourage your efforts to find solutions to the challenges facing nuclear energy: inherent safety features; nuclear energy systems which produce minimal and fully manageable wastes; more economical and efficient reactors of varying sizes, capable of being applied to more diverse uses in a variety of situations and locations; and systems designed to be proliferation resistant and "safeguards friendly" to give the highest assurance of no diversion of nuclear material.

The challenges to the future of nuclear energy require an active response. Recent events have added to those challenges and we are now on notice from an ever more sceptical public

opinion. But the world would not be well served if an important energy choice was foreclosed unnecessarily. When we speak of the hopes and the apprehensions concerning the use of nuclear technology, it is incumbent on all of us to work to maximize the hope and eliminate the sources of apprehension. This is a task worthy of your continued endeavour.