Disposal of spent fuel and high-level radioactive waste: Building international consensus

The need for internationally accepted standards and criteria promises to become even greater in years ahead

by B.A. Semenov

More than 30 years have elapsed since the first commercial nuclear generation of electricity. During this period approximately 125 000 metric tonnes of spent nuclear fuel have been produced. The IAEA estimates that this amount will grow to approximately 200 000 metric tonnes by the year 2000. Some 25% to 30% of this spent fuel is expected to be reprocessed, with the remainder being stored either at the nuclear power plant sites or at specially constructed storage facilities.

At the end of 1991 there were 420 nuclear power plants operating worldwide, supplying 17% of the world's electricity needs. Another 77 plants are under construction worldwide, bringing the total number of plants operating and being built to almost 500. In four countries, more than half of the electricity needs are supplied by nuclear power, while 13 countries obtain at least 20% of their power from this source.

Despite this reliance on nuclear electrical generation and the quantities of the wastes which have been produced, no country has been able to begin construction of a repository for spent nuclear fuel or high-level wastes, and the earliest a repository is projected to be in operation in any country is the year 2010. Disposal of these wastes is perceived by some to be a problem that cannot be satisfactorily solved and it has become a critical obstacle to the development of nuclear power. This article will analyze major reasons for this situation, attempt to place the magnitude of the problem in its proper perspective, describe IAEA programmes to help resolve the issue, and make some recommendations for consideration by countries.

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The present situation

Most countries using nuclear electrical generation have programmes to safely dispose of the waste arisings. Technical alternatives for disposal of spent fuel and high-level wastes have been assessed by several countries and international organizations. Scientific consensus exists that geologic disposal using a system of natural and engineered barriers is the preferred method to be used. Unlike chemically hazardous industrial wastes, the much smaller volumes of spent fuel and high-level waste make containment and isolation a feasible disposal option, and their radiological hazard will decrease with time. Generic studies of geologic disposal conducted by the Swedish KBS, the Commission of European Communities (CEC), and others have concluded that geologic disposal systems can achieve an acceptable level of safety to protect future generations from the radiological hazards associated with these wastes.

During 1991 experts advising the IAEA, the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA), and the CEC issued, on behalf of these organizations, an "international collective opinion". It stated that methods exist to evaluate adequately the potential long-term radiological impacts of a carefully designed waste disposal system and that appropriate use of these safety assessment methods, coupled with sufficient information from proposed disposal sites, can provide the technical basis to decide whether specific disposal systems offer society a satisfactory level of safety.

What is needed now is data from candidate disposal sites that can be used to perform site-specific safety assessments to determine the suitability of these sites for development of repositories. However, in almost all countries

repository programmes encounter public and political resistance to selecting sites for investigation to determine their suitability for development as repositories.

There are several reasons for this gap in confidence in disposal technologies between waste management specialists and the general public, who feel that waste disposal presents unacceptable hazards and environmental risks. The public has understandable apprehensions concerning the effects of ionizing radiation associated with the peaceful uses of atomic energy. These are sometimes aggravated because the public perceives the risks associated with radioactive waste disposal to be similar to those of reactor accidents. The fact that some of the radionuclides present in the wastes have very long half-lives for which it is impossible to provide absolute proof of repository performance is perceived as a problem that cannot be mastered. The public's apprehensions are also caused by a lack of perspective in judging radiation risk compared to others, such as chemically toxic wastes, which present similar hazards. The public generally does not recognize that the nuclear industry has been working for decades to develop the technology to safely manage radioactive wastes — a task which has only recently begun to receive attention for other kinds of hazardous wastes — and that the technology for radioactive waste disposal is much more advanced. A typical product of such concerns is the "not in my backyard (NIMBY)" syndrome, causing *a priori* refusal of disposal in one's own region, neighbouring regions always being preferred. Unfortunately, disposal programmes in many countries lack effective public information programmes to address these apprehensions.

In the interim, spent fuel and high-level wastes continue to be stored while countries consider how to proceed with repository development. How serious a problem is it for the quantities of spent fuel and high-level wastes involved? Fortunately, this situation presents no public health and safety problem, for the technology exists to store these wastes safely for many decades, and while they are in storage, their radioactivity and heat generation rates will decrease as a result of radioactive decay. However, a fundamental principle of radioactive waste management is that the burden of disposing of the wastes should not be left to future generations but should be borne by the generation that benefitted from the activities that produced the wastes. In the current situation, public concerns are preventing this principle from being met. Furthermore, some countries have national laws that require solution of waste disposal problems as a prerequisite to further development of nuclear power. In such cases, the impasse over waste disposal may lead to rejection of a viable alternative for the generation of electrical power and the selection of technologies which damage the environment by contribution of greenhouse gases and acid rain.

International co-operation and the IAEA

There is no one single solution or direction that will remove all the negative perceptions associated with radioactive waste and its disposal. However, by showing that international consensus regarding many aspects of waste management and disposal exists, and by building consensus where it does not yet exist, we would certainly create a more favourable climate for building public confidence. This is a prerequisite for making real progress in the disposal of radioactive wastes. In the field of radioactive waste management, international co-operation and collaboration is not a new concept. For many countries and international organizations, information and technology exchanges and joint R&D efforts have been an integral aspect of their programmes for many years.

There have been three main modes of international co-operation in radioactive waste management:

- through bilateral arrangements between countries and/or organizations;
- on a regional level; and
- through international organizations.

The co-operation has been very successful with emphasis on information and technology exchange, including joint research and development, and demonstration projects. This type of co-operation has many benefits and is extremely practical for several reasons, the first reason being economics.

It makes good economic sense to share the cost of large-scale and/or long-term projects with other organizations. Second, joint activities or exchanges allow organizations to share and learn from each other's experiences, and compare future strategies. The resulting benefit is the prevention of some duplication of effort. International organizations like the CEC, the NEA/OECD, and the IAEA play a major role by facilitating the exchange of information and transfer of technology. Third, joint projects create a support network and a system of formal and informal peer reviews. This external review process enhances and adds technical credibility and validity to national approaches and methodologies. And, finally, co-operation and exchange is required and used by countries as a

means of checks and balances — a sort of calibration.

IAEA programmes

The main objective of the IAEA's waste management programme is to ensure the safe management and disposal of radioactive waste in accordance with the Agency's mandate to promote the safe and peaceful use of atomic energy. The programme's objectives are achieved by assisting IAEA Member States in the safe and effective management of wastes by organizing the exchange and dissemination of information, providing standards and guidance, providing technical assistance and advisory services, and supporting research.

During the next 10 years, more countries will begin disposal operations for low- and intermediate-level wastes, and, by the end of the first decade of the next century, some countries plan to implement the disposal of high-level waste and/or spent fuel in deep geologic repositories. As these national programmes move toward actual implementation of disposal systems, three waste management trends become evident:

- the need for internationally accepted waste management standards and guidelines will increase;
- the increased demand for international peer reviews to complement national review programmes; and
- growing potential for regional and international co-operation in the management and disposal radioactive waste.

The need and call for internationally accepted standards and criteria in radioactive waste management and disposal will become even greater in the years to come, and the IAEA is intensifying its efforts in providing evidence that radioactive wastes can be managed effectively and safely. More specifically, the IAEA is expected to demonstrate harmonization of approaches at the international level by promulgating standards that are developed, discussed, and agreed upon internationally.

RADWASS. In response to this challenge, the IAEA in 1991 established the Radioactive Waste Safety Standards (RADWASS) programme to develop a special series of safety documents specifically directed at radioactive waste management. The purpose of the RADWASS programme is to document existing international consensus in the approaches and methodologies for safe waste management and disposal; create a mechanism to establish consensus where it does not exist; and provide Member States with a comprehensive series of internationally agreed documents to complement national standards and criteria.

RADWASS has been organized in a hierarchical structure of four levels of safety documents. The top-level publication is a document of safety fundamentals which provides the basic safety objectives and fundamental principles to be followed in national waste management programmes. The lower levels include safety standards, safety guides, and safety practice documents. The series has been structured in a logical and clear manner to reflect the systems approach to waste management. The series of documents will encompass all safety-related documents in the waste management area. They will include the decommissioning of nuclear facilities and will be consistent with other IAEA safety related publications. Work on developing the document on safety fundamentals, the four high-priority safety standards, and the three high-priority safety guides is already well under way.

Technical peer reviews and advisory services. Technical peer reviews have been an essential component of national waste management programmes from the very beginning. Peer reviews are important for interpreting and verifying or validating assumptions, R&D results, or conclusions critical to the success of programmes. The requirement for external review or oversight is sometimes mandated by law as in the case of the Technical Review Board for the US Civilian Radioactive Waste Management Programme. While peer reviews may not be legally required in all countries, external reviews are and have been a formal requirement of many programmes. As programmes move toward common phases of development, there will be an increase in the use of independent peer reviews, both domestic and international, to bolster technical confidence, strengthen programme credibility, and more importantly, foster public acceptance of national waste management programmes.

WATRP. The Waste Management Assessment and Technical Review Programme (WATRP) was established to provide a mechanism for technical assessment and independent international peer reviews of waste management strategies and activities in countries with developed nuclear programmes. The objective of WATRP is to assist countries with nuclear power plants and fuel-cycle activities in their evaluation of the technical, operational, safety, and performance features of waste management systems planned or in operation. WATRP can be regarded as a way of assisting Member States in establishing public confidence, as well as offering valuable international technical review on planned national program-

mes. The Agency has provided WATRP reviews to Sweden, the United Kingdom, and the Republic of Korea. Although the WATRP concept is new, the IAEA is receiving considerable interest in this review service.

International protocols and conventions. Conventions or protocols are common mechanisms for international agreements on important and jointly shared concerns. There are several important international conventions in existence today. They include the Basel Convention on Transboundary Movements of Hazardous Wastes and their Disposal, the International Convention for the Prevention of Pollution from Ships (the London Dumping Convention), the IAEA Convention on Early Notification of a Nuclear Accident, and the Convention on the Physical Protection of Nuclear Materials.

The International Conference on Safety of Nuclear Power: Strategy for the Future, hosted by the IAEA in September 1991, recommended that an international nuclear safety convention, which would also include provisions on radioactive waste management and disposal, be developed. The IAEA General Conference, in September 1991, endorsed the idea and the initial steps in defining the possible elements of such a convention. An expert group was established to prepare an outline of the possible elements of such a convention. The scope and content of the convention have not yet been determined. Although it is premature to anticipate the final outcome of this undertaking, it can be said that such a convention could have far-reaching effects. One obvious benefit would be the recognition by the public that their national programmes are adhering to internationally accepted safety standards.

Joint international R&D and demonstration projects. Joint R&D and demonstration projects have been a part of international co-operation for quite some time. Many such projects are already under way, such as natural analogue projects, safety assessment and model validation programmes, and the international Stripa project. As national waste programmes improve technologies for waste management and as actual implementation of waste disposal proceeds, the opportunities for collaboration in R&D will increase.

Also there are several waste management activities that appear to be receiving heightened attention, such as the partitioning and transmutation of actinides and fission products in high-level waste. International co-operation and joint R&D projects in this area would provide a broader technical base, better utilize economic resources, and possibly shorten the period necessary for full scientific evaluation of this concept.

In the past, a number of countries and international organizations have considered the concept of regional and international disposal facilities. For various reasons, these ideas were not realized, but it seems appropriate that this idea should be revisited. As early as the 1970s, there were international studies and proposals to evaluate the technical feasibility and practicality of regional, multinational, or international plutonium storage facilities, as well as studies for spent fuel storage facilities under the same concept. Between 1978-81, the IAEA was directed to co-ordinate two such studies. These studies were completed, published, and presented to Member States, but did not find strong support at the time, primarily for non-technical reasons. The studies showed that such facilities had many merits and positive aspects. Some of the advantages, such as the optimization of existing facilities as regional ones, thus resulting in fewer facilities and economies of scale, are even more applicable today. In fact, 10 years ago, one of the most important arguments in support of this regional concept, is even more important and relevant today: nuclear non-proliferation.

For waste disposal, in particular, there are clear economic, technical, and safety factors that strongly support the regional repository concept. From the economic standpoint, countries with very small nuclear programmes may find cost advantages in using regional or international repositories rather than developing small national disposal facilities. As for safety, one could suggest that if the total number of disposal sites were kept to the very minimum, there would be more control and fewer safety related concerns. Also where spent fuel is the final waste form for disposal, safeguards activities would be much easier to implement and manage under this concept.

Eastern Europe is one area where such a regional concept may be feasible. The countries in Eastern Europe (Bulgaria, Czechoslovakia, Hungary, Poland, Romania, and Yugoslavia) have relatively moderate nuclear energy programmes which will eventually require disposal of high-level waste. For each of these countries to develop its own repository would be costly and difficult. One cannot argue that a half dozen disposal facilities are more environmentally benign, technically sound, economically advantageous, or safer than one regional facility. This consideration is equally applicable to a group of western European countries with moderate nuclear power programmes.

A major obstacle to such regional or multinational facilities is public and political opinion which can likely prevent a country from hosting such a project. In fact, this opinion may prove to be the greatest barrier to the realization of such

Public communication is an important element of nuclear waste management programmes. (Credit: BNFL)

concepts, since many national programmes already face strong domestic opposition to disposal of waste generated within their own borders. The IAEA is now in the early stages of developing a report that will outline the benefits of the regional repository concept. It is our intention that this report, when completed, will serve as a catalyst to encourage preliminary discussions on the subject among countries that could significantly benefit from the use of a regional repository.

Need for national strategies

These actions by the IAEA and other international organizations, while providing valuable assistance to the nuclear community, cannot by themselves resolve the political and public acceptance issues surrounding radioactive waste disposal. What is needed is the development of sound national strategies to bridge the gap between the confidence that specialists have regarding the safety of the geologic disposal concept and the impression that the public and many national decision makers have that such disposal will result in unacceptable hazards and environmental risks to current and future generations.

Some elements of such a strategy would involve:

- agreement on, and articulation of, sound policies and objectives for radioactive waste disposal;
- development of sound, scientifically based programmes to be implemented with technical integrity;
- provision of information to, and effective communications with, the public by the developer; and
- independent oversight and peer reviews by outside organizations.

Taking such measures, which have the goal of improving public understanding of the issues involved and enhancing the credibility of disposal programmes and disposal programme implementers, will make an important contribution to allowing disposal programmes to proceed.

In communicating with the public about disposal programmes, the economic benefits to the community from the construction and operation of a new facility should also be addressed. In some cases, economic benefits to the local population have overcome concerns about the risk of nuclear facilities. The new radioactive waste management law that was promulgated by the French Parliament late in 1991, for instance, contains provisions for consultation with the local government and members of the public, on the formation of public interest groups within the local communities, and for financial compensation of property owners.

The next 20 years will certainly be an interesting and exciting, but critical, time in the field of radioactive waste management and disposal. We must work toward building consensus in all those aspects where international consensus does not yet exist. International organizations such as the IAEA must continue to assist, facilitate, and provide the fora to bridge national and international efforts. Although the opportunities for international co-operation and collaboration should be utilized to their fullest potential, national programmes must continue on a course directed at enhancement of technical excellence, safety, protection of human health and the environment, and continue to build public confidence.

This is the real challenge that faces the waste management community in the coming years. This challenge must be accepted if significant progress in building international consensus on the management and disposal of radioactive waste is to be realized. ❐