

Radioactive waste management in developing countries

New activities have been initiated to address needs and problems

by K.T. Thomas, W. Baehr, and G.R. Plumb

Almost all of the IAEA's Member States produce some types of radioactive wastes.

For most developing countries, nuclear power plants are not the focal point of radioactive waste management activities today. Only about 7% of the world's installed nuclear power capacity is in countries from developing areas of the world. Seven developing countries in Asia, Latin America, and the Mediterranean region were operating 24 nuclear power plants at the beginning of 1988. Yet nuclear power will become a growing source of radioactive wastes in years ahead as nuclear power units under construction in developing countries become operational.

At the present time, developing countries are mostly concerned with the management of nuclear wastes generated from medical centres, research institutes, industrial facilities, mining operations, and research reactors. In certain instances, management of such wastes has lapsed causing serious accidents. Radiation source mismanagement has resulted in fatalities to the public in Mexico (1962), Algeria (1978), Morocco (1984), and Brazil (1987).

The activities of the Agency in waste management have therefore laid emphasis on advising developing Member States on the management of wastes from the uses of radioactive materials. This is being carried out in an integrated manner through activities of the Division of Nuclear Fuel Cycle and Waste Management, technical assistance programmes, and the waste management advisory programme (WAMAP), an interregional technical co-operation project.

The Department of Technical Co-operation's considerable work in waste management projects involves identifying countries needing assistance, setting priorities, delineating a project's scope, and ensuring that projects are implemented effectively.

The objective of these activities is to support the countries to develop the required expertise for self-

sufficiency in safe management of radioactive wastes. What follows are details of the Agency mechanisms in place to meet the above objectives.

Technical co-operation projects

Since 1976, there have been 35 technical co-operation projects on radioactive waste management covering 22 countries. Currently 15 countries receive different types of technical assistance through altogether 22 projects. (*See accompanying table.*) The number of countries receiving technical assistance in waste management is expected to increase as developing Member States focus on the implementation of national programmes.

For successful implementation of these projects, efforts are made to correlate them with national programmes, needs, and strategies. The IAEA assessments take into consideration not only the technical but also the broader aspects of the proposals requesting assistance. This helps to ensure that the awarded projects meet the main requirements for integrated national development of safe radioactive waste management systems.

Co-ordinated research programmes

Co-ordinated research programmes (CRP) of the Agency cover specific research and development topics of wide interest and importance in radioactive waste management. Participation has ranged broadly to involve both developed and developing Member States, thus serving as an excellent forum enabling transfer of technical information and data to the developing countries.

Currently there are eight ongoing and planned CRP programmes dealing with different topics in the field of waste management. The CRPs on migration of radionuclides from shallow land burial of radioactive wastes, decontamination and decommissioning of nuclear facilities, evaluation of low- and intermediate-level radioactive solidified waste forms and packages, and the use of inorganic sorbents for waste management are particularly useful to developing countries.

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Features

Technical assistance to Member States in radioactive waste management

	Expert assistance of project officer	Advice on assignment of experts	Advice on equipment procurements	Fellowships/scientific visits
Algeria	X	X	X	X
Bangladesh	X	X	X	X
Bulgaria	X	X	X	X
Chile	X	X	X	X
China	X	X	X	X
Cameroon	X	X		X
Egypt	X	X	X	X
Indonesia	X	X	X	X
Republic of Korea	X	X	X	X
Peru	X	X	X	X
Philippines	X	X	X	X
Portugal	X	X		
Syria	X	X	X	X
Thailand	X	X	X	X
Turkey	X	X	X	X

Training courses and study tours

A number of scientists from developing countries have been trained in advanced countries in radioactive waste management as part of national technical co-operation projects. In addition, national, regional, and interregional training courses are being held on the subject. Between 1976 and 1989, there have been one national, two regional, and eight interregional training courses and study tours on radioactive waste management benefiting 206 participants from 60 countries. The last interregional course on waste management was held in Karlsruhe, Federal Republic of Germany, in September–October 1988.

To meet the needs of developing countries for ‘‘hands on’’ training in the practical aspects of immobilization of spent radiation sources, regional courses are being planned in the post-1989 period.

Radioactive waste management advisory programme (WAMAP)

In late 1986, the IAEA decided to augment its waste management efforts by starting an advisory programme to provide greater assistance to developing Member States. WAMAP — the acronym for Waste Management Advisory Programme — is today helping developing countries by assessing their needs in waste management and related areas; reviewing operational and planned programmes; evaluating available expertise and manpower, laboratories, equipment, and services.

Teams of experts in various waste management disciplines visit a Member State, upon its request, for a comprehensive overview of waste management needs, practices, procedures, and institutions. Teams directly assist in the practical development and implementation of waste management options, plans, and methods for

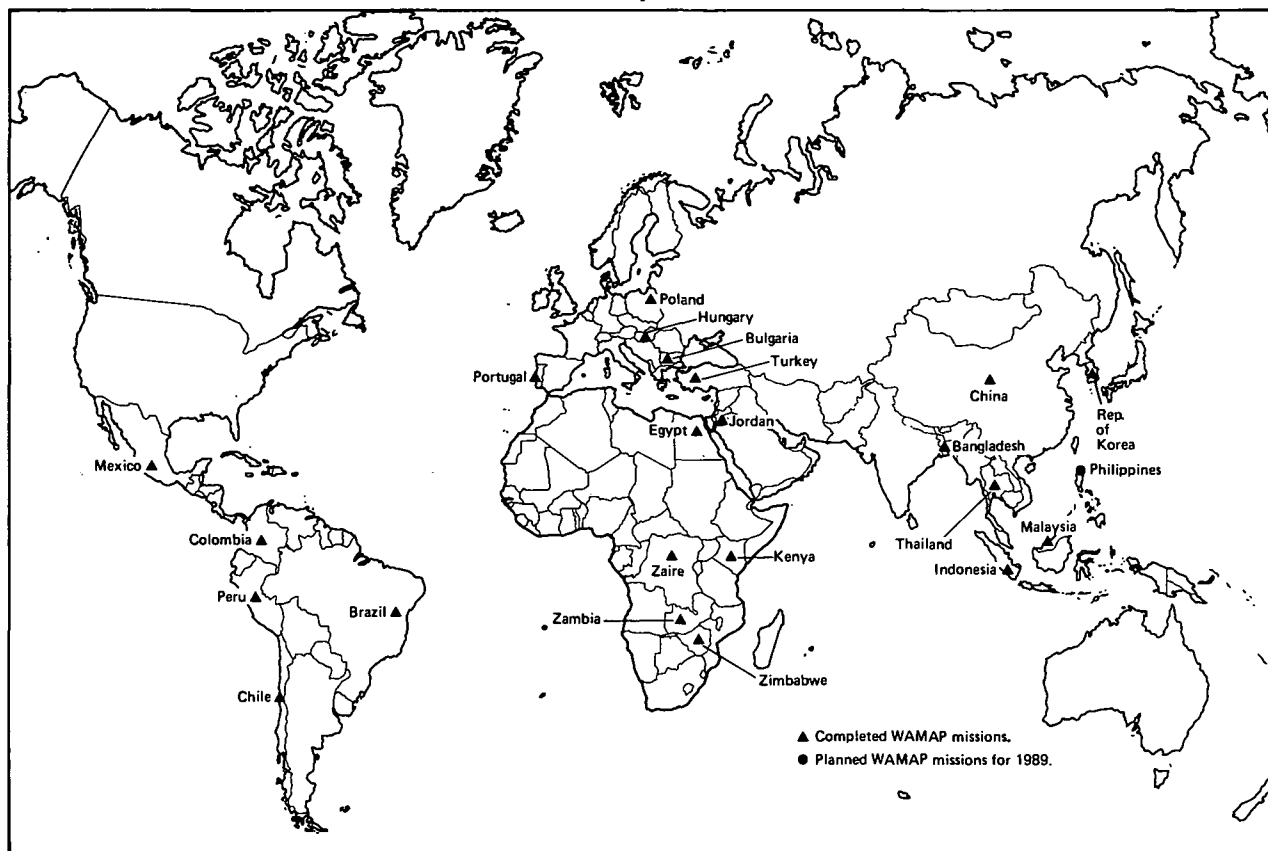
waste segregation, treatment, conditioning, storage, and disposal, all within the context of the country’s policies, programmes, and financial situation. Specific recommendations are given for the safe promotion of radioactive waste management in countries visited.

WAMAP missions began in 1987, building upon the traditional base of information and expertise established at the IAEA over the past 30 years. Twenty-two missions have been organized so far, with one more scheduled to be completed by the end of 1989. (*See accompanying map.*) This indicates that a global interest exists for WAMAP.

WAMAP missions have identified a number of areas needing national attention for implementation of their waste management programmes safely. Not only due recognition of the needs for safe management of radioactive wastes is necessary, but countries have to have policies and plans for short- and long-term integrated waste management based on modern practices and criteria. To achieve this, the required legislation, infrastructure, and trained staff are necessary along with means for information exchange and the required finances. Application of safety criteria for making proper safety assessments in waste management is necessary. Waste disposal work — especially with respect to proper siting of repositories — is another area needing emphasis in countries faced with this problem. WAMAP’s recommendations have been received positively by all countries.

The results of the WAMAP missions clearly indicate that due attention should be given for waste management needs at national levels. Before initiating programmes involving, for example, uses of radioisotopes in hospitals and industry, planning on the waste management needs is required at the national level. The Agency can only give advice and certain technical assistance to develop the expertise for the management of wastes; the countries themselves have to solve their problems.

Countries visited by WAMAP missions



As part of its safety and advisory services, the IAEA provides expert missions to Member States upon their request under its Waste Management Advisory Programme.

Initiatives in managing waste from nuclear applications

Radiation sources, starting with radium, have been in use for many decades. They are now used in a wide range of applications in the fields of research, medicine, industry, and agriculture. Some of the isotopes of importance are cobalt-60, caesium-137, radium-226, iridium-192, americium-241, strontium-90, and plutonium-238. All these sources become radioactive wastes after their useful lives are over.

Since the application of radioactive materials in industry, medicine, and other fields are universal without any distinction between developed and developing countries, excepting the magnitude of the application, the problem of managing spent sources exists in all IAEA Member States. In industrialized countries, however, an adequate regulatory infrastructure usually exists with control and inspection mechanisms to minimize problems that could occur.

Regarding the number and type of the spent sources in the developing countries, no comprehensive and reliable information is available. It is also doubted whether some countries themselves have this information. It is estimated, however, that the radium in stock in developing countries is between 250 and 500 grams. Radium use

for cancer treatment, which started early in the century, is being superseded by the use of other isotopes.

As already mentioned, accidents from mishandling of spent sealed sources have occurred in recent years in several Member States to cause fatalities and serious injuries to the public. In a circular letter issued to Member States in 1988, the IAEA Director General cautioned countries about the serious hazards involved with spent radiation sources unless proper control is exercised in their safe management and disposal. If obsolete sealed sources are not managed properly or lost in the public domain, the consequences are generally severe. The sources are high-integrity capsules that contain a small mass of specific isotope, and the danger from exposure to an intact device is greatly increased if the capsule is dismantled. Dispersion of the radioactive content may cause wide external and internal personal contamination.

In view of the importance of problems related to spent sealed sources, a number of new tasks have been proposed in the Agency. Specifically, it is planned to:

- review and assess both the magnitude and nature of the radiological and disposal problems associated with old medical radium sources in Member States and the role the Agency should play in this connection; and
- consider including information on spent sources in the waste management database currently being devel-

WAMAP background details

Since 1987, expert missions under the Agency's Waste Management Advisory Programme (WAMAP) have visited 22 countries. All told, 24 experts from eight Member States and the IAEA participated. The visited countries have different levels of nuclear activities: 11 countries have research reactors, or associated centres and programmes; seven have nuclear power plants operating or being built, or nuclear fuel cycle facilities; six have uranium or monazite programmes; and six have radioisotope applications. All of the countries have responded positively to WAMAP recommendations.

Based on the missions, a number of general observations have emerged:

- the benefits of centralized control and clearly identified regulatory and management responsibilities are not recognized
- national waste management programmes are not planned in an integrated manner
- the required legislation is not in place in many countries
- there is need for training, augmentation, and motivation of staff

- safety concepts are not practised in a systematic manner; in many countries there are no safety criteria or appreciation of the need for safety analysis and assessments, or quality control for waste management
- spent radiation sources are a major problem in most countries
- information exchange with other countries is lacking
- an acute shortage of finances exists, resulting in low priority for waste management; the IAEA is the main source for research and development and improvements in waste management practices in many countries
- information on wastes and projection of future waste arisings are lacking in most countries
- siting programmes for repositories are not being carried out systematically
- decontamination and decommissioning needs are neglected areas
- public acceptance problems are surfacing in more and more countries, the effects of which are being underestimated
- IAEA assistance is required, and sought after, for improvements in waste management.

oped as a supplement to the Agency's activities in the waste management area.

A technical manual on handling, conditioning, and disposal of spent sealed sources has already been prepared to offer simple but straightforward advice to countries engaged only in radioisotope applications in medicine, research, and industry. The manual provides information on characterization; legislation; responsibilities; options in management; and conditioning of sealed sources. (See accompanying figure outlining options for management.)

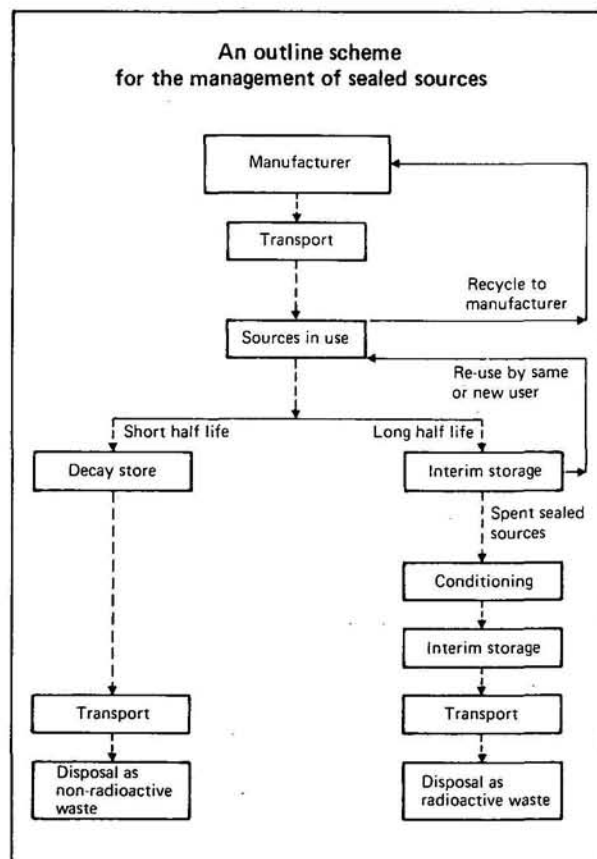
In addition to the preparation of guidance documents, IAEA assistance in the management of spent sealed sources includes a complementary video film, training programmes, practical assistance in the design of systems, and expert missions.

● **Training programmes.** There are initiatives to hold several regional and interregional courses devoted to the subject. Meantime, urgent advice has been given in lectures within courses covering general waste management and radiation protection aspects. In 1990, a regional training course on spent radiation sources management is proposed to be held in an African country.

● **Practical assistance.** A video film covering a typical conditioning and immobilization demonstration was urgently prepared to aid rapid understanding. However, direct hands-on demonstration now seems essential for many countries and expert assistance through WAMAP and special missions are under consideration.

The assistance given by the IAEA has been to promote self-reliance in Member States through the establishment of regulatory systems and the technical capability to safely handle, store, and dispose of obso-

lete sealed sources. The alternative of resolving many of the spent source problems with the co-operation of the industrialized countries that supply the sources has been explored at length. Generally, the sources supplied in the future will be the subject of an agreement to accept their return when obsolete. However, despite the



efforts, many old sources in developing countries will still require proper management and disposal, making the policy of self-reliance essential.

Practical approaches and guidance

Developing countries are generally facing different problems — and therefore have different immediate needs — than industrialized countries in the day-to-day safe handling of radioactive waste. The reasons for this are because their nuclear power programmes are less mature or just beginning, so the base of experience is smaller, and the overall industrial and regulatory infrastructures are frequently not as firmly established. Many other developing countries have no nuclear power programmes but generate wastes from the use of radioisotopes in industry, medicine, research, and other fields.

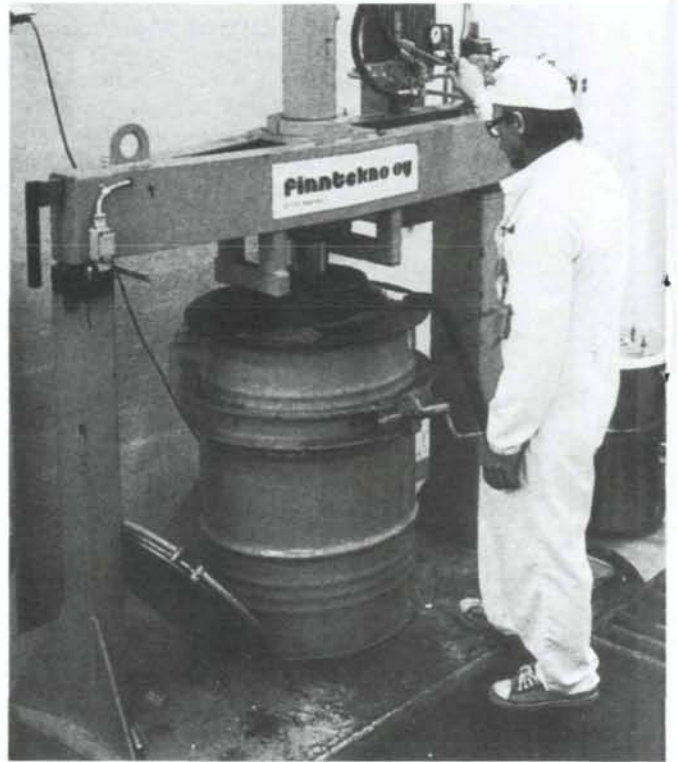
The IAEA's programmes are placing particular emphasis on activities to advise and train specialists and to transform proven practices and technologies from industrialized to developing countries. Activities in radioactive waste management are continually under review to meet the needs of Member States and to reflect the current status of work in the field.

In view of the Agency's wider responsibilities to give global guidance, the needs of developing countries are particularly given importance. The work done so far has been useful to all countries. However, it is being increasingly felt that in addition to publication of reports, the IAEA activities should also meet the needs of Member States, especially developing Member States, on practical approaches in implementation of waste management programmes and projects. Some of the new activities initiated by the IAEA during the last 3 years are for the purpose of meeting this demand.

Technical manuals

A number of technical manuals have been issued by the IAEA covering aspects of radioactive waste management, particularly directed at the needs of developing countries. Others are in preparation. They cover topics including the:

- Handling, conditioning, and disposal of spent sealed sources
- Minimization and segregation of radioactive waste
- Interim storage for decay of untreated and conditioned wastes
- Handling, treatment, and conditioning of solid radioactive wastes
- Treatment and conditioning of radioactive animal carcasses and biological materials
- Treatment and conditioning of radioactive effluents
- Treatment and conditioning of radioactive organic liquids
- Treatment and conditioning of spent ion-exchange resins from research reactors
- Design of a centralized waste processing and storage facility.



At the Loviisa nuclear plant in Finland, some types of radioactive wastes are compacted using a hydraulic press. (Credit: YJT, Finland)

Comparison of a coal-fired power plant with a nuclear plant producing the same amount of electric energy

	Coal-fired power plant	Nuclear power plant
Fuel needed per year	3 000 000 m ³	3 m ³
Waste produced	400 000 m ³	1000 m ³ *
Amount of toxic metals in waste produced	3000 m ³	1 m ³

Source: *Nuclear Power and Fuel Cycle: Status and Trends*, IAEA, (1989).
* Includes waste produced during fuel fabrication and reprocessing.