IAEA ACTIVITIES IN THE FIELD OF TREATMENT, CONDITIONING AND DISPOSAL OF LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTE

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ABSTRACT

The paper describes the present activities of the International Atomic Energy Agency in the field of treatment, conditioning and disposal of low- and intermediate-level radioactive waste. The short information on the background, scope and status of technical documents and guidelines under preparation has been provided.

An important part of the Agency's activities in the field of waste management is technical assistance and support of developing countries in their national waste management programs. The current status and the future trends of the Waste Management Advisory Program for developing countries (WAMAP) have been presented.

INTRODUCTION

The increasing role being played by nuclear energy in electricity generation has confronted many countries with the need to develop appropriate systems for the management and disposal of radioactive waste. Radioactive materials are also used extensively in labelled chemicals in research laboratories, in hospitals, in industrial and agricultural applications and for environmental studies. In many developing countries, such activities are the main source of radioactive waste.

The basic objectives of the Agency's work in waste management is to assist Member States in the safe management of radioactive wastes arising from the peaceful uses of atomic energy and radioactive isotopes. This is achieved by exchange of information, the development of guidelines and international recommendations, the development and exercising of responsibilities under international and regional conventions, the encouragement and sponsorship of research work, the provision of training, and the consideration of waste management and disposal in the framework of international cooperation.

The Agency's mechanisms for review, dissemination and exchange of information are by means of arranging conferences, symposia, seminars, technical committee and advisory group meetings, the use of recognized experts as consultants, sponsoring of research programs and training courses, study tours, etc. Support research programs and awarding contracts to laboratories in developing countries. The Agency awards fellowships, sponsors scientific visits and provides expert missions and field experts to assist Member States in implementing their programs.

The objective of this paper is to present the current activities of the Agency in the field of treatment, conditioning and disposal of low- and intermediate-level radioactive waste. This field, in spite of a lot of practice and experience, is still proving to be the subject of great interest of both developing and developed countries. This interest has been expressed at many Agency meetings.

All activities in the entire waste management program are determined by the Secretariat under general guidance from the various regular or ad hoc technical committees, advisory groups and the Scientific Advisory Committee of the Agency. The selection of some particular topics is based on the current status of technologies, new experience in implementation and practical needs of Member States.

TREATMENT AND CONDITIONING

A large number of technical reports and regulatory guidance have been published during approximately 30 years of Agency activities in the field of radioactive waste management. Most of them however were published after 1975. The last five years were especially productive in providing Member States with guidance and technical review papers in this field. In this five-year period, the updating of some basic documents covering treatment and conditioning of liquid and solid wastes were carried out (Table I). These basic documents review all aspects of treatment and conditioning of waste mostly in general terms.

After that, it was decided to develop a series of technical reports with a more detailed review of different waste treatment and conditioning technologies, which would be useful for specialists both in developed and developing countries. Some of these reports revise and update the versions of previous reports. Others describe new methods developed recently. The primary goal of these reports is to collect all available information on the subjects and provide the Member States with an up-to-date review of some particular subjects in treatment and conditioning of low- and intermediate-level radioactive waste. This paper provides a brief presentation of technical reports and regulatory guidance which are now under preparation within the

TABLE I

Treatment and Conditioning of Low-and Intermediate-Level Radioactive Waste (1980-1985)

Management of radioactive waste from nuclear power plants - Code of Practice	Safety Series No. 69 (1985) (English) (1986) (French) (in press) (Russian)
Management of radioactive wastes produced by users or radioactive materials	Safety Series No. 70 (1985)
Design of radioactive waste management systems at nuclear power plants	Safety Series No. 79 (1986)
Guide to the safe handling of radioactive waste at nuclear power plants	Technical Reports Series No. 198 (1980)
Management of wastes from the refining and conversion of uranium ore concentrates to uranium hexafluoride	IAEA-TECDOC-241 (1981)
Conditioning of low-and intermediate-level radioactive wastes	Technical Reports Series No. 222 (1983)
Treatment of low-and intermediate-level solid radioactive wastes	Technical Reports Series No. 223 (1983)
Treatment of low-and intermediate-level radioactive liquid waste	Technical Reports Series No. 236 (1984)
Treatment of spent ion-exchange resins for storage and disposal	Technical Reports Series No. 254 (1985)

Agency's current program in the field of treatment, conditioning and disposal of low- and intermediate-level radioactive waste.

The following technical reports are now under preparation.

Techniques and Practices for Pre-Treatment of Low- and Intermediate-Level Radioactive Solid and Liquid Wastes

The subject of "pre-treatment" of waste has never been published as a separate document within the Agency waste management program. However, pre-treatment is a very important step in handling waste since every step in waste management strategy limits or directs all succeeding steps. Proper pre-treatment of waste can create significant positive effects throughout the rest of the waste management cycle. *This document* describes more common pre-treatment technologies such as:

- collection and segregation
- size reduction
- chemical adjustment
- on-site transportation and storage.

This document has been submitted for publication and will be published this year.

Immobilization of Low- and Intermediate-Level Radioactive Waste with Polymers

This subject also has never before been covered by a separate Agency publication. This technical report describes the currently available processes and technologies for the solidification of low- and intermediate-level radioactive wastes with polymers. It describes in detail those processes and polymer materials which have been used or are being used to solidify various wastes. In addition, processes under development and those which have recently been developed and appear to be promising are also included in this report. A special effort has been made to include information regarding the physical and chemical properties of polymer waste forms over a range of waste types and waste concentrations. This information was compiled from test results reported in the literature and can be used to assess the long-term behavior of polymer waste forms and to establish a basis for their applicability to specific wastes and disposal environments.

This report will be submitted for publication later this year and will be published in 1989.

Management of Abnormal Radioactive Wastes at Nuclear Power Plants

There are many Agency documents including Safety Standards, Safety Guides and Technical Reports dealing with management of radioactive waste generated during normal operation of nuclear power plants. Occasionally, however, like in other industries, nuclear power plant operators may need to deal with waste arisings which were not specifically anticipated at the design stage and for which no specific provision was made in the design of the waste management systems. In practice, the occurrence of abnormal wastes will be very rare. Some nuclear power plants may never have abnormal wastes to manage but it is nevertheless prudent to consider how such wastes could be managed if they arose. The circumstances leading to the generation of abnormal wastes may include accidents and unplanned major maintenance/repair/replacement of plant items and so the nature of the wastes cannot be predicted in precise terms.

This report is intended to give guidance to nuclear power plant operators on the technical means available to enable abnormal wastes, should they arise, to be managed safely.

In addition to providing information on waste management techniques, this report also addresses the important subjects of pre-planning and provisions for abnormal waste management decision-making of the management of abnormal wastes and the importance of adequate waste characterization.

In order to further guide the readers on how abnormal wastes may be managed in practice, brief information has been included on some past occurrences at various power plants generating abnormal waste and how this waste has been managed.

This report is at the final stage of preparation and we are going to submit it for publication later this year. As a further step in this area the Agency is going to prepare a Safety Guide on management of abnormal waste at nuclear plants. The Agency is going to start the preparation of this Guide in 1989.

Options for Treatment and Solidification of Organic Radioactive Waste

The nuclear fuel cycle generates a variety of low- and intermediate-level solid and liquid organic radioactive wastes.

The quantities of organic waste are small compared to nearly all other radioactive wastes. However those wastes require some specific treatment and conditioning options different from other wastes.

Suitable management of organic waste can involve several stages, i.e. from the arising of waste to their safe disposal. The primary goal of this report is to review the treatment and conditioning methods of organic radioactive wastes for storage and disposal. Some of the process stages discussed in the report have achieved operational status, while others are still in the research and development phase. The wastes considered in the report arise from nuclear fuel cycle operation, including fuel fabrication, reactor operation, fuel reprocessing, decontamination operations and from fuel cycle research and development.

This report will be submitted for publication later this year.

Improved Cement Solidification of Low- and Intermediate-Level Radioactive Waste

This technical report is in a preliminary stage of preparation, developing from the first draft. This report is intended to review the processes in use, the cementation practices at various establishments, and emphasizes the recent developments and improvements which enhance the characteristics of cement waste forms through the use of additives and other modifications and the techniques for allowing certain types of waste to be incorporated into cement. The draft of this document will be discussed at a Technical Committee meeting in May this year and after being finalized by consultants, it will be submitted for publication in 1988.

As was mentioned before, the Agency's activities in the field of waste management focus not only on collection, review and dissemination of technical information, but on the development of guidelines and implementation of national waste management programs. Within this area, the IAEA is developing documents under three programs:

- waste handling and treatment
- underground disposal
- environmental aspects

In 1985 the Agency published the Code or Practice on Management of Radioactive Wastes from Nuclear Power Plants. The objective of this document was to provide Member States with broad guidance regarding basic safety matters for the management of radioactive wastes from nuclear power plants. It emphasizes what safety requirements shall be met in management of radioactive waste. How these requirements shall be met is a subject of a range of Safety Guides and Recommendations supported in this Code of Practice. Some of them have been published already, for example, Safety Guides entitled: "Design of Radioactive Waste Management Systems at Nuclear Power Plants" and "Operational Management for Radioactive Effluents and Waste Arising in Nuclear Power Plants." The others are under preparation (Safety Guide on Design and Operation of Radioactive Waste Incineration Facilities) or being planned for preparation in the near future (Safety Recommendations on Management of Radioactive Waste Generated during Accident Conditions at Nuclear Power Plants).

All these regulatory documents are issued or will be issued by the Agency for use by Member States in the context of their own nuclear safety requirements. These documents are written in a form to enable Member States, should they decide, to make their contents directly applicable to activities under its jurisdiction. Consistent with accepted practice, recommendations provided in these regulatory documents can be used by Member States as firm recommendations or as desirable options for implementation of their national safety regulations. The final decisions and legal responsibilities always rest with the Member States. However, because these recommendations are based on current practice in Member States with advancec nuclear technology and reflect the more reasonable and necessary safety considerations, they can be very useful for both developed and developing countries.

UNDERGROUND DISPOSAL

A major effort to provide guidance and to document the technology for disposal of low- and intermediate-level waste was completed in 1985. Approximately 10 reports on this topic were published from 1980 through 1985. These reports cover essentially all phases of disposal activity including site selection, repository design and operation, waste criteria, shutdown and surveillance. All of these reports were published in the IAEA Safety Series or Technical Reports Series and are available from the IAEA. Table II gives a list of these reports. Because disposal of low- and intermediate- level waste is an extremely important topic in which technology is developing rapidly, these reports will be updated periodically and new programs will be begun.

One area that has not been dealt with previously is that of mixed wastes; that is, wastes that are chemically hazardous and also contaminated with radionuclides. We will begin work next year on a technical report that outlines basic considerations for disposing of mixed waste, and it is expected that this program will grow.

The report on treatment of wastes from unplanned events was mentioned previously. The event at Chernobyl unfortunately provided a case where such waste was not only produced, but also disposed of in place. The waste form in this case is the entombed reactor. The emplacement of concrete as a barrier around the reactor itself, its location near the surface and at the water table, and the additional use of grout walls to divert ground water away from the reactor are all very similar to normal shallow land burial practices. These similarities were discussed in a recent meeting of the Agency's Technical Review Committee on Underground Disposal, and it was recommended that beginning in 1988, the Waste Management Section begin reports on this topic.

TECHNICAL ASSISTANCE

An important part of the Agency's activities in the field of waste management is technical assistance and support of developing countries in their national waste management programs. Generally, the needs of developing countries deal with management of waste produced by users of radioactive materials for various

TABLE II

Guidelines and Technical Publications on Underground Disposal

Shallow ground disposal of radioactive waste: A guidebook	Safety Series No. 53 (1981)
Site investigations for repositories for solid radioactive waste in shallow ground	Technical Reports Series No. 216 (1982)
Disposal of low-and intermediate-level solid radioactive waste in rock cavities: A guidebook	Safety Series No. 59 (1983)
Site investigations, design, construction, operation, shut-down and surveillance of repositories for radioactive waste in rock cavities	Safety Series No. 62 (1984)
Design, construction, operation, shut-down and surveillance of repositories for solid radioactive waste in shallow ground	Safety Series No. 63 (1984)
Safety analysis methodology for radioactive waste repositories in shallow ground	Safety Series No. 64 (1984)
Operational experience in shallow ground disposal of radioactives wastes	Technical Reports Series No. 253 (1985)
Techniques for site investigation for underground disposal of radioactive wastes	Technical Reports Series No. 256 (1985)
Performance assessment for underground disposal of radioactive waste disposal systems	Safety Series No. 68 (1985)
Acceptance criteria for disposal of radioactive waste in shallow ground and rock cavities	Safety Series No. 71 (1985)

applications in medicine, agriculture and industry, waste produced by nuclear research centers, nuclear power plants and waste from the mining and milling industry.

Currently, there are about 17 developing countries receiving assistance from technical cooperation projects on various aspects of management of low- and intermediate-level waste. Table III gives some details of the countries receiving technical assistance in radioactive waste management.

As can be seen from this table, technical assistance is being given to countries in most of the developing regions of the world. As part of these projects, the Agency provides field experts, fellowships, scientific visits, equipment and supplies.

The Waste Management Section is providing technical assistance for low level waste treatment, conditioning and disposal to a number of countries that have developing nuclear power industries. One example is Yugoslavia where low level wastes from the Krsko reactor have been stabilized with cement and stored in drums at the reactor site. They are now actively working to select a site and a design for a shallow land repository for this waste. Similarly, in Austria, low-level wastes from their research reactors and medical programs are being stored at the Seibersdorf research center. In cooperation with the Waste Management Section, the Austrians are using computer models to determine favorable site characteristics that will then be used in selecting a disposal site. Bangladesh and Indonesia have similar needs. One IAEA expert has just returned to Vienna after spending a month in Bangladesh and another expert mission to Indonesia is scheduled for 1987.

Institutional training on waste management is provided by organizing study tours and training courses. For example, the last Interregional Training Course on Management and Disposal of Radioactive Waste was held in Canada in May 1986. The next one on Management of Radioactive Waste will be held in the Federal Republic of Germany in September this year. An important form of the Agency assistance and support for developing countries is encouragement of research in the waste management area by conducting Coordinated Research Programs (CRPs) or by sponsoring the research of individual scientific groups.

While the work being done by the Agency in the radioactive waste management field has considerable merits, as it offers Member States guidelines, recommendations and technical reports on various aspects of this field, the Agency's assistance to developing countries could be further improved if it were evaluated, planned and coordinated on an integrated basis in the most appropriate and optimal manner to achieve the necessary goals effetively and economically. In order to meet the needs of developing countries for advice on practical approaches to the integrated development of radioactive systems, the Agency initiated last year a Waste Management Advisory Program (WAMAP) to provide assistance in the field. This program will thus complement the present activities of the Department of Technical Cooperation in waste management and related fields. The objective of this program is to accelerate efforts aimed at giving more effective assistance to developing Member States in their plans for implementation of an integrated management program for low- and intermediate-level radioactive wastes. Assistance would be given in particular in the establishment of regulations, for analyzing the problems and selecting the most suitable solutions, for designing, constructing and operating the facilities and establishing the related services for organizing a regulatory body for licensing and inspecting the facilities. The program will also examine the possibility of sharing expertise, engineering know-how, laboratory facilities and infrastructure available within the same country or in contiguous geographical areas. WAMAP will thus help developing Member States to gain international experience in the assessment and practical development and implementation of waste processing, storage and disposal projects, and result in the enhancement of safety in the use of nuclear energy.

TABLE III

Technical Assistance to Member States
on Radioactive Waste Management

Country	Type of Assistance			
	Assistance of project officer as expert	Advice on assignment of experts	Advice on equipment procurement	Fellowships/ scientific visits
Algeria	X	X	X	
Bangladesh	X	X	X	
Brazil	X	X		X
Chile	X	X	X	X
China	X	X		X
Egypt	X	X	X	X
Hungary	X	X		X
Indonesia	X	X	X	X
Korea, Republic	X	X	X	X
Mexico	X	X	X	X
Peru	X	X	X	X
Philippines	X	X	X	X
Syrian Arab Republic	X	X		
Thailand	X	X	X	X
Turkey	X	X	X	X
Venezuela	X	X		
Yugoslovia	X	X		X