STATUS OF THE IAEA WASTE MANAGEMENT PROGRAM

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ABSTRACT

The IAEA's on-going Waste Management Program includes the areas of handling, treatment, conditioning, storage and disposal in land and at sea of various radioactive wastes, the assessment of environmental consequences of radionuclide releases as well as the decontamination and decommissioning of nuclear facilities.

The main activity of the IAEA in these fields is: to collect, review and disseminate information, to develop internationally agreed guidelines, to encourage and sponsor research and to provide technical advice and training for Member States upon request.

Along with the growing interest of Member States in recent years in waste management, the Agency's activities in the area have gathered added momentum. In the last five years about 80 scientific and technical reports have been prepared, ten coordinated research programs were concluded and seven have been initiated. Seventeen developing countries receive technical assistance in the field of waste management.

INTRODUCTION

The main objective of the International Atomic Energy Agency in the field of radioactive waste management is to assist its Member States in achieving safe and effective management of radioactive waste so as to provide adequate protection for man and his environment. This objective is achieved by exchange of the most up-to-date information on technical, scientific and regulatory aspects; the development of internationally acceptable guidelines, standards and recommendations; the development and exercising of responsibilities under international and regional conventions; the encouragement and sponsoring of research work; and the provision of training and technical assistance to Member States upon request.

The Agency's mechanisms for fulfilling these tasks are by means of organizing conferences, symposia, seminars, technical committee and advisory group meetings; by inviting recognized experts as consultants; by sponsoring and co-ordinating research programs; by arranging training courses, study tours etc. The Agency awards fellowships, sponsors scientific visits and provides expert missions and field experts to assist Member States in implementing their national waste management programs.

The information collected or generated by the IAEA is available as Proceedings of conferences, symposia, seminars and panels, Technical Reports, Safety Series, unpriced IAEA Technical Documents and public information booklets. Within the Safety Series, standards and codes of practice, guides, recommendations and safety related procedures and data are published and generally used as a base for national regulations and practices.

The IAEA waste management activity includes the areas of handling, treatment, conditioning, storage and disposal in land and at sea of various radioactive wastes, the assessment of environmental consequences of radionuclide releases as well as the decontamination and decommissioning of nuclear facilities.

THE MAIN EFFORTS AND SOME ACHIEVEMENTS

Due to the increasing interests of Member States in safe and effective management of nuclear waste, the IAEA has enhanced its effort particularly in two areas: disseminating current technical information and assisting the developing countries in the planning and implementation of their national waste management programs.

Dissemination of Technical and Scientific Information

The demands for new and comprehensive technological information and inputs from developing countries have been substantially increased in the recent past. In endeavoring to satisfy these needs, however, the IAEA maintains a proper balance between the activities related to the interests of both developed and developing countries, although nearly 80% of our 112 Member States belong to the latter category.

As an illustration of the enhanced IAEA effort in the exchange of information on waste management, more than half of the total (about 150) publications issued since 1960 were published within the last five years, therefore, they can be considered as rather up-to-date information. For these achievements the Agency owes a great deal to those many recognized experts from various countries who have contributed in the development of these documents. Their contribution is largely responsible for the good quality of the IAEA reports which we expect to continue in the future. In this five year period the up-dating of some basic documents were carried out, on handling, treatment and conditioning of solid and liquid wastes of all activity levels. Two safety standard-level documents on NPP and sea dumping respectively have been published. Twenty-four safety and technical reports were issued on the subject of underground disposal. A majority of them deal with the design, construction, operation, shut-down, surveillance, regulatory, safety and quality assurance aspects of the disposal of low- *and intermediate*-level solid wastes into rock cavities or shallow land

repositories. The proceedings of a large, comprehensive International Conference on Radioactive Waste Management held in Seattle, Washington, USA in 1983, organized jointly with USDOE were published in five volumes. Several new reports were developed e.g. on the characterization of waste forms of various activity levels for storage and disposal; and on decontamination and decommissioning of nuclear facilities. In the environmental field, safety documents were prepared on environmental assessment methodologies for sea dumping; on the oceanographic and radiological basis for the definition of high-level wastes unsuitable for dumping at sea and on the radiological impact of radionuclides dispersed on regional and global scale. A joint IAEA/WHO booklet "Nuclear Power, the Environment and Man" was published in four official languages by the IAEA. The 16th annual edition of the "Waste Management Research Abstracts" was issued recently. It contains over 600 abstracts summarizing the ongoing research carried out in 33 countries.

More detailed information on these efforts can be obtained from the Annex to this paper. This Annex lists the IAEA priced publications on waste management, issued since 1980.

Technical Assistance for Developing Countries

The Technical Assistance Program of the IAEA has been growing consistently, at an average rate of 18 percent a year since 1969, due to the generous voluntary contributions of developed countries, worth a total of $38.3 million for implementation in 1986. The demands for technical assistance, also in the waste management field, have been increasing steadily. At the present time, 17 Technical Cooperation Projects are in progress in the regions of Asia, Latin America and Africa. As a part of these projects, the Agency provides field experts, fellowships, scientific visits, equipment and supplies. In the near future it is proposed to give the Technical Assistance activity in the waste management program of the IAEA a higher priority and an integrated Waste Management Advisory Program (WAMAP) is being planned to extend the scope of IAEA services for developing countries.

Institutional training on waste management has been provided by organizing three study tours (1969, 1979, 1982), three training courses (1982, 1983, 1985) and three seminars (1982, 1983, 1984). An additional training course in Canada and a regional seminar for Latin America on waste management options is scheduled to be held in Brazil later this year.

An important form of the IAEA program is through the encouragement and support of research in the waste management area by conducting Coordinated Research Programs (CRPs), or by sponsoring the research of individual scientific groups. during the last 10 years, ten coordinated research programs have been successfully completed and their results published. In addition, five CRPs are in progress and two are in preparation. There has been broad participation by both developed and developing Member States.

THE IAEA'S WASTE MANAGEMENT PROGRAM

The IAEA's programs are prepared several years in advance on a broad scale by consultation with the representatives of Member States and by means of other formalized advisory bodies, e.g. Senior Advisory Group to review the waste management program; Technical Review Committee on Underground Disposal; Scientific Advisory Committee of the IAEA, etc. This present Conference, for example, is also one of the less formal review fora of our activities. On several occasions, we have received comments following these meetings. The last time was in 1985 when we had useful comments on our sub-program for handling, treatment, conditioning and storage of radioactive wastes.

In the preparation of our 1987/88 program, we have given emphasis to the consideration of waste management as an interdisciplinary task that can be tackled by an integrated systems approach connecting together all steps from the generating of wastes via their handling, treatment, transport to final disposal with the assessment of long term safety as the most essential element.

The Agency's waste management program, therefore, will concentrate efforts on studying more comprehensive problems in a wider scope and in an overall integrated system basis. The new program focusses on three areas of activity:

1. Handling, treatment, conditioning and storage of waste,
2. Disposal of radioactive waste,
3. Decommissioning of nuclear facilities.

This will provide for continuity of the work, although some activities have been terminated and others will start. Extended cooperation or coordination will be continued both inside the IAEA (e.g. with the Radiation Protection Section, Monaco Laboratory, etc.) and other international organizations within or outside the UN family as WHO, UNIPEDE, UNEP, ILO, IMO, etc., and OECD/NEA, CEC and others, respectively.

The planned IAEA program in the three areas of activity is as follows.

Handling, Treatment, Conditioning and Storage of Waste

Studies on the radioactive waste processing have been carried out since the inception of the IAEA. Member States having even a modest nuclear application program (e.g. use radioisotopes in medicine, industry or research) are faced with the problem of radioactive waste generation, and therefore, development and implementation of processes to segregate, collect, store and treat wastes, to reduce their volumes, and produce immobilized waste forms for long term storage or disposal are needed. The safe and economic containment of radioactive waste is a basic requirement in the continual use and growth of nuclear energy. This area of activity consists of three program elements: the treatment of low- and intermediate level wastes, high-level and alpha-bearing wastes and gaseous wastes.

Low- and Intermediate Level Wastes

Special emphasis continues to be placed on the processing of low- and intermediate-level waste generated from the operation and maintenance of nuclear power plants. In view of the potential for growth of nuclear power in countries with developing nuclear programs, there will be a need to provide technical assistance and guidance on acceptable practices for the handling, treatment and conditioning of wastes generated in nuclear power plants. The IAEA program in the future has been established to meet this challenge. As supporting documents to the recently published Code of Practice on Management of Radioactive Waste from Nuclear Power Plants, safety guides will be prepared on design of waste management facilities for nuclear power plants and on design and

operation of waste incinerators. For consideration of abnormal conditions a technical report is being developed on handling and treatment of radioactive waste from unplanned events at NPPs. Technical information will be disseminated on volume reduction technology for low- and intermediate-level combustible waste. A relatively new process will also be covered in an IAEA publication: the immobilization of radioactive waste with polymers. In up-dating of the previous IAEA publications, a technical report will be developed with extended scope on design and operation of cement-incorporation systems for conditioning of radioactive wastes.

An international symposium is planned in 1988 on management of low- and intermediate-level wastes, which might be jointly organized with other international organization(s).

Two coordinated research programs are or will be in progress in the near term, one on the evaluation of low- and intermediate-level waste forms and packages; and the second on use of inorganic sorbents for liquid waste treatment and backfill for underground repository. Both programs will support the safe disposal of nuclear wastes generated by NPPs.

High-level and alpha-bearing waste

Radioactive waste processing technologies for this category are an important part of the nuclear development of Member States with mature fuel cycle programs. The IAEA activity in this field has been concentrated on the minimization of the waste volume generated at the source, collection and segregation of wastes at their origin, treatment of wastes to reduce their volumes, and conditioning of wastes to stable forms and packages for transport, storage and disposal. The latter technology reviews will also be extended to the conditioning of unreprocessed spent fuels.

Continuing the efforts which have resulted in the publication of Technical Reports on cladding hulls and fuel hardware management, and on chemical durability and related properties of solidified high-level waste forms, will be followed by the preparation of further documents on treatment and conditioning of alpha-bearing wastes, on design and operation of high-level waste vitrification and storage facilities, and on solidification of organic radioactive waste. In the development of the unreprocessed spent fuel disposal option, which is under consideration in various countries, a review will be carried out in evaluating the technology and safety factors of conditioned spent fuels as a final waste form. A coordinated research program is in progress on performance of solidified high-level waste forms and engineered barriers under repository conditions.

Gaseous Wastes

The performance of off-gas cleaning systems of various nuclear facilities, as a particular waste management area, receives special attention in the IAEA program.

A Technical Report on design of off-gas and air-cleaning systems at NPPs is nearing completion. As a continuation of the publication series on the management of specific airborne radionuclides, e.g. krypton-85, tritium, radioiodines and semivolatile radionuclides a document is in preparation on the conditioning, storage and disposal of iodine-129 which is one of the hazardous long-lived radionuclides in the global environment.

Technical guidance will be developed on the design and operation of off-gas cleaning systems at both high-level liquid and low- and intermediate-level waste treatment and conditioning facilities and at waste incinerator facilities.

In the area of ventilation and filter techniques, documents on comparison of HEPA filter testing methods and on testing and operation of off-gas cleaning systems were issued and reports on the design of ventilation and air-cleaning systems at non-fuel cycle facilities and on the development of particulate filters for nuclear facilities are planned.

The off-gas clean-up problems in abnormal conditions at nuclear facilities are very important issues. A coordinated research program on the retention of iodine and other airborne radionuclides during abnormal and accident conditions has been launched which will result in the publication of a report on the subject.

Disposal of Radioactive Waste

As an implementation of the system approach concept in an IAEA waste management activity various on-going program elements will be integrated under the heading of disposal of radioactive waste. This integrated area of activity will cover underground disposal, sea disposal and radioactive discharges program components. This area of activity consists of the above three problem components which are described as follows:

Underground disposal

Underground disposal being the prevailing option to isolate safely radioactive waste from the biosphere, its importance in the IAEA program has grown.

An integrated program on the underground disposal of radioactive waste was launched in 1977 to develop a series of reports based upon the needs of Member States involved with this problem. A Technical Review Committee on Underground Disposal (TRCUD) was established in 1978 to review and periodically guide the Agency and in particular to examine and make recommendations on the publications developed in this field.

The first phase of this integrated program was completed by the publication of 24 safety series and technical reports, a majority of them being relevant to the disposal of low- and intermediate-level waste into shallow ground and rock cavities.

In the second phase of this activity, which began in 1984, the emphasis has been placed on disposal of high-level waste in deep geological formations including development of reports on siting, design, construction and operation and on criteria and codes of practice for such disposal. It is hoped that the technical aspects of the topics to be covered under this phase would have matured to a sufficently high level to prepare guidelines on the development of deep geological repositories.

Technical guidance on engineering aspects of deep geological disposal will be prepared on siting, design, construction, operation, shut-down and closing of repositories as well as on in situ experiments, borehole plugging and shaft sealing related to such repositories.

Safety standard reports will be developed on international standards and criteria for underground disposal of high-level waste, a code of practice on underground disposal and the necessary guides dealing with all the major options of geological disposal are also planned. A safety document on the regulation of underground repositories for disposal of solid radioactive waste will also be developed.

The Agency has been involved in attempts at reaching an international concensus on the 'de minimis' as applied to both marine and terrestrial environments since the late 1970s. Guidance is being developed on principles for exemption of radiation sources and practices from regulatory control. The guidance will be applied to derive numerical exempted quantities of radionuclides in various applications (e.g., disposal of low level wastes by sanitary landfill, incineration and into the marine environment, disposal of decommissioning waste, and recycling of slightly contaminated materials).

A coordinated research program on geochemistry of neptunium and other long lived radionuclides will be initiated to collect information in this specific field.

An IAEA international symposium on siting, design and construction of underground repositories is being held this week in Hanover, Federal Republic of Germany. Approximately 50 papers are being presented in five technical sessions, on technical, regulatory and safety aspects of waste disposed in shallow land, rock cavities or deep geological formations.

Sea Disposal

Disposal of radioactive waste into the sea either by dumping from ships or by discharge from land based sources is an alternative option to land disposal, for some waste types. In the IAEA waste management program, sea disposal is covered by activities of both the Waste Management Section, Division of Nuclear Fuel Cycle and the Monaco Laboratory of Marine Radioactivity, Department of Research and Isotopes.

The task of the Waste Management Section is to keep under review the IAEA's Definition and Recommendation under the Convention on Prevention of Marine Pollution by Dumping of Wastes and other Matter (commonly known as the London Dumping Convention), to update the relevant data base, and contribute to interagency activities relating to the environmental impact of radionuclides in the marine environment. The document which gives a definition of high-level radioactive waste that is prohibited from dumping at sea and recommendations for the dumping of other radioactive wastes which do not fall under the above definition was revised in 1985 and the next revision is expected in 6 to 8 years from now.

Procedures and data were established for evaluation of ocean disposal to radioactive waste as an annex of the above revised Definition and Recommendations. In the interim period of revisions, additional reports to be published in the Safety Series will be developed jointly with the Radiation Protection Section on the principles to be used in establishing upper bounds of individual dose for application to the exposure of members of the public to different sources. These principles will be applied inter alia to the specific case of sea dumping. Publications will also be prepared on the evaluation of the impact on marine biota of dumping and procedures will be developed for site-specific modelling and pathway analysis for coastal marine environment. The joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) of eight UN organizations has undertaken to develop coastal models for this venture.

The activities of the Monaco Laboratory within the waste management program provide scientific data useful to Member States and international or regional organizations for evaluating the environmental impact of radionuclides entering the marine environment from nuclear installations. It also develops improved analytical techniques for monitoring marine radioactivity.

Environmental Aspects of Waste Management

An aim of this part of the program is the establishment of a coherent international approach to the development of safety assessment methodologies for radioactive waste disposal.

Radiological and environmental impact assessment activities were started in 1978 by the development of a key document on generic models and parameters for assessing the environmental transfer of radionuclides from routine releases, which provides guidance on models for use in critical group dose assessment. Since then guidance has been given on methods for collective dose assessment on the modelling of atmospheric dispersion and guidance is currently being developed on methods for assessing the reliability of environmental transfer model predictions. This subject will be continued in cooperation with the Commission of European Communities (CEC) and International Union of Radioecologists (IUR) through the organization of a seminar on environmental transfer model reliability in 1987.

Attention will be given to the data needs of assessment models by assembling an international data base of radionuclide transfer factors for the terrestrial environment (in collaboration with IUR and CEC). The problem of the radiological impact assessment in non-temperate environments will be the subject of another project.

The impact of waste disposal on the natural environment is being studied by means of review of information on the effect of radiation on ecosystems. In the area of environmental migration of radionuclides, two coordinated research programs have recently been concluded, one of the role of sediments in the transport and accumulation of radioactive pollutants in rivers and estuaries, and the other on the environmental migration of radium and other contaminants present in the waste from mining and milling of uranium. As a follow up activity to the latter, a monograph on environmental behavior of radium is being prepared with contributions from more than 50 experts in the field worldwide.

One of the most important issues at present in the radioactive waste management area is the demonstration of long-term safety of proposed disposal procedures. In relation to this, the Agency is sponsoring a coordinated research program on the subject of migration and biological transfer of radionuclides from the shallow land burial of radioactive waste. It is also following closely international studies of natural analogues as a means of obtaining more reliable predictions of long-term migration of radionuclides in geological media.

Information will be provided for Member States which is both technically accurate and readily understood by the public on the established

radioactive waste disposal methods with the objective of achieving improved public understanding and acceptance in this area.

Decommissioning of Nuclear Facilities

The decontamination of decommissioning of nuclear facilities is of great interest to Member States because several hundreds of nuclear facilities will be decommissioned in the next two decades and many uranium and thorium mine sites and tailing piles will have to be stabilized and/or rehabilitated.

Since 1973 when work was started in the field of decommissioning of nuclear facilities nine reports have been published.

The IAEA's activities in this area have increased during the past few years and future activities will be enhanced considerably. As a result of an intensive review of the program and the needs of Member States, a long-range program using an integrated systems approach covering all the technical and regulatory steps associated with the decommissioning of nuclear facilities is being developed. The data base resulting from this work is required so that Member States can decommission their nuclear facilities in a safe, timely, and cost-effective manner and the Agency can effectively respond to requests for assistance.

The integrated data base being developed will cover all the technical and regulatory aspects of decontamination and decommissioning.

In a report, an outline of the general principles and factors to be considered in the decommissioning of land-based nuclear reactors in a safe and orderly manner was provided, it contains discussions on the planning, management, quality assurance, and release criteria to carry out a decommissioning project successfully. Information has also been provided on the technical considerations important to decommissioning, as well as briefly looking at methods available for decontamination and disassembly of a nuclear facility and outlining areas of decommissioning methodology where improvements can be made.

In general, the wastes arising from the decommissioning of nuclear facilities are not significantly different from other radioactive wastes. Since the methods for treating, conditioning, storing, transporting, and disposing of radioactive wastes are well covered in other IAEA reports, no new documents on decommissioning wastes are planned in the immediate future.

Technical reports deal in greater depth with the engineered and technical aspects of decommissioning, reviewing the techniques used or being developed for the decontamination of nuclear facilities not only for decommissioning but also to facilitate operation, inspection, maintenance, and modifications to operating plants. A state-of-the-art review of the methods and technology used for the decommissioning of nuclear facilities has also been given to complement and reinforce data published previously and, in particular, to provide in-depth technical data for those areas of decommissioning technology not covered elsewhere, including costs and financing of decommissioning operations.

A follow-up to these reports, the IAEA is preparing or planning technical reports on decommissioning topics such as: methods of reducing occupational exposures; technology, safety, and economics of recycling materials; decontamination and demolition of concrete and metal structures; monitoring for compliance with unrestricted use criteria; the status of the development and use of remote systems technology in decommissioning; and the development of regulatory procedures and criteria.

In the area of uranium and thorium mining and milling, a Code of Practice will be issued soon on the management of waste produced from these sources. Technical reports will be prepared on the design of impoundment and disposal facilities for tailings, conditioning of tailings for disposal and the methodology and technology used in the stabilization and rehabilitation of tailing piles. Also, factors relevant to the decommissioning of facilities, mines and sites and managing of waste from such operations will be reviewed.

SUMMARY

The International Atomic Energy Agency has a large and comprehensive program on radioactive waste management, including the areas of handling, treatment, conditioning, storage, disposal in land and at sea of various types of radioactive waste and the assessment of environmental consequences of radionuclide-releases as well as the decontamination and decommissioning of nuclear facilities.

The IAEA has enhanced its effort particularly in two areas: disseminating up-to-date technical and scientific information and assisting its Member States in the planning and implementation of their national waste management programs to achieve a safe and effective management of radioactive waste so as to provide adequate protection for man and his environment.

ANNEX

IAEA (Priced) PUBLICATIONS ON WASTE MANAGEMENT SINCE 1980

Proceeding Series

Underground disposal of radioactive waste (1980)

Management of gaseous wastes from nuclear facilities (1980)

Management of alpha-contaminated wastes (1981)

Impacts of radionuclide releases into the marine environment (1981)

Environmental migration of long-lived radionuclides (1982)

Management of wastes from uranium mining and milling (1982)

Conditioning of radioactive wastes for storage and disposal (1983)

Nuclear power experience Vol. 3 (1983)

Radioactive waste management (1984)

Safety Series

No.	Title
51	Development of regulatory procedures for the disposal of solid radioactive waste in deep continental formations (1980)
52	Factors relevant to the decommissioning of land-based nuclear reactor plants (1980)
53	Shallow ground disposal of radioactive wastes: A guidebook (1981)
54	Underground disposal of radioactive waste: Basic guidance (1981)
56	Safe assessment for underground disposal of radioactive waste (1981)
57	Generic models and parameters for assessing environmental transfer of radionuclides from routine releases: exposures of critical groups (1981)
58	Concepts and examples of safety analyses for radioactive waste repositories in continental geological formations (1983)
59	Disposal of low- and intermediate-level solid radioactive wastes in rock cavities: A guidebook (1983)
60	Criteria for underground disposal of solid radioactive wastes (1983)
61	Control of radioactive waste disposal into the marine environment (1983)
62	Site investigations, design, construction, operation, shutdown and surveillance of repositories for low- and intermediate-level radioactive waste in rock cavities (1984)
63	Design, construction, operation, shutdown and surveillance of repositories for solid radioactive wastes in shallow ground (1984)
64	Safety analysis methodologies for radioactive waste repositories in shallow ground (1984)
65	Environmental assessment methodologies for sea dumping of radioactive waste (1984)
66	The oceanographic and radiological basis for the definition of high-level wastes unsuitable for disposal at sea (1984)
68	Performance assessment for underground radioactive waste disposal system (1985)
69	Management of radioactive waste from nuclear power plants - Code of Practice (1985)
70	Management of waste produced by users of radioactive materials (1985)
71	Acceptance criteria for disposal of radioactive solid waste in shallow ground and rock cavities (1985)

Technical Reports Series

No.	Title
198	Guide to the safe handling of radioactive wastes at nuclear power plants
199	Separation, storage and disposal of krypton-85
201	Radioiodine removal in nuclear facilities: Methods and techniques for normal and emergency situations
202	Environmental effects of cooling systems
203	Handling of tritium-bearing waste
207	Tritium in some typical ecosystems
209	Current practices and options for confinement of uranium mill tailings
215	Site investigations for repositories for solid radioactive wastes in deep continental geological formations
216	Site investigations for repositories for solid radioactive wastes in shallow ground
220	Control of semivolatile radionuclides in gaseous effluents at nuclear facilities
222	Conditioning of low- and intermediate-level radioactive wastes
223	Treatment of low- and intermediate-level solid radioactive waste
229	Handling and storage of conditioned high-level wastes
230	Decommissioning of nuclear facilities: Decontamination, disassembly and waste management

232 Disposal of radioactive grouts into hydraulically fractured shale

234 Management of tritium at nuclear facilities

236 Treatment of low- and intermediate-level liquid radioactive wastes

243 Testing, monitoring of off gas clean-up systems at nuclear facilities (1984)

247 Sediment K_ds and concentration factors for radionuclides in the marine environment (1985)

249 Decontamination of nuclear facilities to permit operation, inspection, maintenance, modification or plant decommissioning (1985)

250 The radiological impact of radionuclides dispersed on a regional and global scale: Methods for assessment and their application (1985)

251 Deep underground disposal of radioactive wastes: Near-field effects (1985)

253 Operational experience in shallow ground disposal of radioactive wastes (1985)

254 Treatment of spent ion-exchange resins for storage and disposal (1985)

256 Techniques for site investigation for underground disposal of radioactive wastes (1985)

257 Chemical durability and related properties of solidified high-level waste forms (1985)

258 Management of cladding hulls and fuel hardware (1985)