

## **An Overview of IAEA Activities to Support Predisposal Management of Radioactive Wastes in Member States - 12334**

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### **ABSTRACT**

The International Atomic Energy Agency (IAEA) promotes safe and effective management of radioactive waste and has suitable programmes in place to serve the needs of Member States in this area. These programmes cover the development and use of safety standards, planning, technologies and approaches needed for the management of different types of radioactive waste, resulting both from the nuclear fuel cycle and nuclear applications. In the predisposal area, the assistance to Member States covers a wide range of topics, including policy and strategy, inventory assessment, technologies and approaches for waste minimization, selection of technical options for waste processing and storage, improvement in operating practices at nuclear facilities, optimization of waste management capacity, etc. and is delivered through the publication of technical guidance documents, coordinated research projects, networks, technical cooperation projects and organization of training and technical review services. This report presents an overview of recent IAEA accomplishments aiming to support activities in predisposal management of radioactive waste with focus on technological aspects.

### **INTRODUCTION**

Radioactive waste arises from nuclear power generation, associated nuclear fuel cycle activities and from various nuclear applications. Depending on the origin, radioactive waste can occur in different physical state (solid, liquid, gas) and can have a variety of characteristics such as activity levels and half-lives of the radionuclides present in the waste. The volumes and generation rates of radioactive waste also vary depending on the type and scale of nuclear activities. The International Atomic Energy Agency (IAEA), among other activities (Fig. 1), promotes safe and effective management of radioactive waste and has suitable programmes in place to serve the needs of Member States in this area. These programmes cover the development and use of safety standards, planning, technologies and approaches needed for the management of different types of radioactive waste through its entire life cycle from generation up to final disposal. It is to be noted that almost eighty per cent of the IAEA's 151 Member States do not have nuclear power or fuel cycle programmes and use radionuclides principally in research, medical, industrial, and agricultural applications. The Agency's projects are carefully balanced to be beneficial to all Member States regardless of the level of technical sophistication that a country may have reached in the use of nuclear energy.

The Waste Technology Section (WTS) of IAEA has the responsibility to collect, review, update and disseminate information on safe, efficient and sustainable waste management technologies

to Member States, to promote the use of these technologies, and to nurture cooperative research. In the area of predisposal, the work of WTS covers all of the major steps that are



Fig. 1. The IAEA departments (see web site: <http://www.iaea.org/OurWork>)

carried out prior to disposal viz. characterization, pre-treatment, treatment, conditioning and storage (see the web page: [http://www.iaea.org/OurWork/ST/NE/NEFW/wts\\_home.html](http://www.iaea.org/OurWork/ST/NE/NEFW/wts_home.html)). The activities in support of predisposal management cover a wide range of relevant topics such as policy and strategy, inventory assessment, analysis of costing and waste management economics, waste minimization, selection of technical options for waste processing and storage, improvement in operating practices at nuclear facilities, optimization of waste management infrastructure, development of technologies etc. Established Agency mechanisms are used to conduct these activities and to deliver assistance to Member States through publications, peer reviews, coordinated research projects and direct assistance through Technical Cooperation program. The following sections provide an overview of IAEA WTS's recent activities in predisposal.

## PREDISPOSAL ACTIVITIES

### Publications

To disseminate technical information the Agency publishes a range of documents under its Technical Reports Series, Technical Documents (TECDOCs) and Nuclear Energy Series. A large number of documents have been published over the years in the predisposal area (Fig. 2).

Some highlights of the documents now under preparation and some documents that were completed in the last five years are presented below.

### Waste management strategies

A recently published Nuclear Energy Series document *Policies and Strategies for Radioactive Waste Management* [1] highlights the main elements of national policy for safe management of

spent nuclear fuel and radioactive waste. It notes that national policies and adequate strategies can vary considerably depending on, among other things, the nature and scale of the generation of radioactive material in a country and have to take into account national priorities and circumstances.



Fig. 2. Predisposal-related IAEA publications (see web page: [http://www.iaea.org/OurWork/ST/NE/NEFW/Technical\\_Areas/WTS/predisposal-publications.html](http://www.iaea.org/OurWork/ST/NE/NEFW/Technical_Areas/WTS/predisposal-publications.html))

The following documents that should provide guidance on how to implement waste management strategies of waste generators, processors or disposal operators in Member States are presently under preparation:

- *Methodology for Establishing an Inventory of Radioactive Waste and for Assessing the Subsequent Management Needs*
- *Selection of Technical Solutions for the Management of Radioactive Waste*
- *Economics of Radioactive Waste Management*

These documents are envisaged to provide support not only to technical experts but also to planners, economists and other professionals that are involved in development and implementation of waste management strategies.

### **Waste minimization**

Activities in support of waste minimization are aimed at reducing the amount and activity of radioactive waste to a level as low as reasonably achievable. Publications on this topic cover all stages in the life cycle of nuclear facilities from design, to operation and finally decommissioning. The goal is to achieve waste minimization by reducing waste generation and

by means such as recycling and reuse, and treatment, with due consideration for secondary as well as primary waste. Guidance is included in several documents, one that is published already, *Waste Minimization Considerations at the Design Stage of Nuclear Facilities* [2], and others that are being finalized for publication such as:

- *Organization and Technical Options for Waste Minimization during Operation and Maintenance*
- *Minimization of Liquid and Solid Radioactive Waste generated at NPP Sites - VVER Reactors*
- *Techniques and Technologies for the Reduction of Radioactive Discharges from Nuclear Power Reactors*
- *Decay Storage of Radioactive Effluents from Medical and other Institutional Applications and Monitoring during Discharge*

### **Waste categorization, characterization and acceptance criteria**

Categorization is a convenient tool to facilitate operational waste activities (e.g., segregation, treatment, conditioning, etc). Characterization of various categories of waste and various kinds of waste packages plays an essential role in the smooth conduct of activities at different stages in the life cycle of radioactive waste and so does the establishment of waste acceptance criteria. These aspects are covered in a number of Agency documents: *Categorizing Operational Radioactive Wastes* [3], *Strategy and Methodology for Radioactive Waste Characterization* [4] and *Determination and use of Scaling Factors for Waste Characterization in Nuclear Power Plants* [5]. A new IAEA publication on *Approach to develop Waste Acceptance Criteria for Low and Intermediate Waste* is under preparation.

### **Technical assistance in development of predisposal facilities in the Member States with small volumes of radioactive waste**

This work is targeted at Member States generating small volumes of radioactive waste including disused sealed sources from nuclear applications and research. The technical assistance is supported by the publication of guidance documents covering design, construction, licensing and management of small waste processing and storage facilities. One document is already published, namely *Licence Applications for Low and Intermediate Level Waste Predisposal Facilities: A Manual for Operators* [6]. The following documents are under preparation:

- *Guidance for the Development of Management System Procedures for Small Scale LILW Predisposal Facilities*
- *Modular Design of Processing and Storage Facilities for Small Volumes of Low and Intermediate Level Radioactive Waste including Disused Sealed Sources*

The modular concept is chosen for facility design to provide maximum flexibility that allows easy adjustment to changing needs in terms of capacity and variety of waste streams. To be published as a design engineering package, this work includes a number of processing and storage module options and provides guidance on selection of the appropriate options for

particular applications. With the help of information provided in this package it is expected that the user will be able to develop technical specifications with adequate design descriptions for procurement of processing and storage modules.

### **Innovative approaches and new developments**

While major focus of WTS work in the area of predisposal technologies relates to guidance on the understanding and use of conventional technologies to manage existing waste, some work is also carried out to capture challenges that could arise from innovative reactors and associated fuel cycles, new developments in technologies for the treatment of problematic waste streams and new approaches in technology deployment such as [7,8] as well as:

- *Processing of Waste from Innovative Types of Reactors and Fuel Cycles*
- *Considerations for the Application of Mobile Processing Systems for Radioactive Waste Management*

### **New predisposal handbooks**

Work has been started recently on preparing a series of comprehensive state of the art technical handbooks covering the full range of predisposal waste management steps by consolidating, restructuring and updating of information in a large number of existing Agency publications in this area. The new handbooks will be published as Nuclear Energy Series Technical Reports. The following is a list of handbooks that are proposed to be prepared over the next few years:

1. *Characterization, categorization and monitoring of radioactive waste, waste forms and waste packages*
2. *Pre-treatment of low and intermediate level liquid and solid waste*
3. *Treatment of low and intermediate level liquid waste*
4. *Treatment of low and intermediate level solid waste*
5. *Management of gaseous waste*
6. *Conditioning of low and intermediate level liquid, solidified and solid waste including DSRS*
7. *Processing of high level waste and spent nuclear fuel declared as waste*
8. *Storage of radioactive waste and conditioned waste packages*

These handbooks are expected to assist professionals in Member States involved in field implementation of predisposal facilities by providing information on selection of technical options, design and operation in a structured way. Documents covering topical themes and issues as and when they arise will continue to be published.

### **Coordinated Research Projects (CRPs)**

While the Agency does not conduct any in-house R&D activities, its Coordinated Research Projects (CRPs) foster R&D in Member States on topics of mutual interest and importance. Participation is broad based, involving both developed and developing Member States, and

serves as an effective mechanism for exchange of technical information and data on the CRP topic. Coordinated research projects are typically 3 to 5 years in duration, and involve 2 to 3 research co-ordination meetings for all principal investigators. The results of CRPs are published as Agency TECDOCs. The following is a brief description of two new CRPs that have been launched and one that was completed recently:

#### **Treatment of irradiated graphite to meet waste acceptance criteria for disposal**

Radioactive graphite constitutes a major waste stream which arises during the decommissioning of certain types of nuclear installations. Worldwide, a total of around 250 000 tonnes of radioactive graphite, comprising graphite moderators and reflectors, will require management solutions in the coming years. This CRP will investigate the treatment of irradiated graphite to facilitate exchange of information and technological experiences on new developments in the area, to identify innovative technologies to be applied for conformity with modern safety and economic requirements. The results may be of assistance in Member States' graphite-disposal strategies, complementary to the investigations of CARBOWASTE.

#### **Processing technologies for high level waste, formulation of matrices and characterization of waste forms**

This CRP will address problems in the area of high level waste immobilization and is of interest to countries that have either adopted the closed fuel cycle or could decide to do so in future. It will contribute to the solution of existing and anticipated future problems related to processing techniques, properties of matrices, and characterization of waste forms. The CRP objectives are to encourage further research and development and exchange of information amongst Member States on: (a) improved processing techniques to ensure more effective performance of existing plants and to address future needs, arising from innovative fuel cycles and flowsheets; (b) formulation of vitreous and ceramic matrices for immobilization of high level waste to achieve higher waste incorporation, better processing features, enhanced durability, and to address new waste compositions; and (c) characterization of waste forms.

#### **Performance and behaviour of cementitious materials in long term storage and disposal of radioactive waste**

The objective of this CRP was to investigate the behaviour and performance of cementitious materials in an overall waste conditioning system based on the use of cement, including waste packages, waste-form and backfill material, as well as interaction and interdependencies of these individual elements during long term storage and disposal, and understand the processes that can result in the degradation of their physical and chemical properties. The project was started in 2007 involving 26 research organizations from 21 Member States and completed in 2010 [9]. A comprehensive publication summarizing the results of this CRP and containing detailed reports of all contributing researchers is under preparation.

#### **Technical Cooperation Projects**

Direct technical assistance to recipient Member States in predisposal area is provided through technical co-operation (TC) projects administrated by the IAEA Department of Technical Co-operation with technical support of WTS staff. This assistance is delivered in the form of expert advice on topics of interest, procurement of equipment, scientific visits to facilities and organizations, training fellowships in advanced organizations, national workshops and training courses.

Country-specific issues and problems are normally dealt with through national TC projects. These projects are designed to address the specific needs of a given Member State. For topics that are of generic interest to a specific region or regions, the assistance is provided through regional or inter-regional TC projects.

Countries supported through existing national TC projects for the management of their institutional (non-NPP) waste include Bangladesh, Belarus, Chile, Columbia, Croatia, Egypt, Lithuania, Mexico, Moldova, Romania, Serbia, Tunisia, Vietnam, etc. The common elements in these projects are retrieval and processing of legacy waste, waste characterization, conditioning of liquid waste, and assistance in design and/or operation of waste processing and storage facilities.

Technical assistance through national TC projects is also provided to pre-disposal activities for operational and decommissioning waste streams of Ignalina NPP in Lithuania, Chernobyl NPP in Ukraine and Bohunice A1 NPP in Slovakia. The common elements between these projects that are coming in focus for technical assistance are same type of reactor in Lithuania and Ukraine that are pursuing decommissioning in a similar timeframe, and a need to deal with problematic waste streams that are result of nuclear accidents in Bohunice A1 and Chernobyl Unit 4. In addition support for predisposal management of NPP or legacy waste has been provided to Korea, China, Mexico, Slovenia, Iran and Iraq.

The regional project on Quality Management of Radioactive Waste in Central and Eastern Europe provides adequate means for organization of on-the-job training course with standardized syllabus in Moscow SIA RADON for the younger operators of low level waste processing and storage facilities of participating Member States. It also provides an opportunity for organization of two workshops per year for operating waste managers devoted to common topics on various issues of management of either NPP waste or institutional waste in the region.

Predisposal technical support will continue in the new TC cycle 2012-13. Members States to be supported through national projects include Argentina, Georgia, Iraq, Jordan, Latvia, Mexico, Serbia and Ukraine. Countries in the European region will continue to be supported through regional projects.

### **Training courses**

Training Courses provide an opportunity to train participants from Member States that need information and guidance on safe predisposal management of radioactive waste based on cost-effective technological solutions and good practices. Such Training Courses are regularly organized based on standardized training modules that include:

- Two week training course for waste operators based on standardized syllabus that combines lectures and technology demonstrations and is best conducted in a designated regional Centre of Excellence, for example Moscow SIA RADON as mentioned above.
- Two week training course for designers, operators and regulators based on an integrated package that combines technology, safety and security for setting up modular waste processing and storage facilities and is targeted at Member States with small volume of waste generation.

Two weeks training courses have been organized from 2005. These events also provide an opportunity to present, discuss and collect feedback on the draft technical documents developed by Agency.

The new developments include longer training up to six weeks devoted to predisposal. The course programme includes four weeks devoted to general overview of all aspects of radioactive waste management and two weeks of specialised training in selected areas. Practical exercises and demonstration of applied methods, operation of facilities, field and site visits are also included. Two such courses were successfully held at Technical University of Clausthal (TUC), Germany in 2010 and 2011 with focus on waste disposal. Another course, specially focussed on predisposal management, is envisaged in 2012 in collaboration with Moscow State University and Moscow SIA RADON.

## **Networks**

In response to the need and interest of Member States a new Network named LABONET was launched in 2011 (Fig. 3). This is the latest addition to the set of Networks being supported by the Waste Technology Section, the others being in the areas of disposal, decommissioning and environmental remediation.

LABONET is a network of laboratory-based centres of expertise involved in the characterization (by non-destructive and destructive testing) of low and intermediate level radioactive wastes. The purpose of this network is to facilitate the sharing international experience in the application of proven, quality assured practices for the characterization of waste and waste packages. In particular the IAEA intends to:

- Support organizations or Member States with less advanced nuclear programmes for characterization of radioactive waste, by making available the relevant skills, knowledge, management practices and approaches from Member States with mature operating nuclear facilities and characterization laboratories;
- Develop an expanded range of training and demonstration activities with a regional or thematic focus providing hands-on, user-oriented experience and disseminating proven analytical procedures;
- Facilitate sharing and exchange of knowledge and experience amongst organizations with characterization facilities in operation, in pursuit of good practices and assuring longer term knowledge management.



- Create a forum in which experts' advice and technical guidance may be provided on the Agency's programme in the area of waste management.

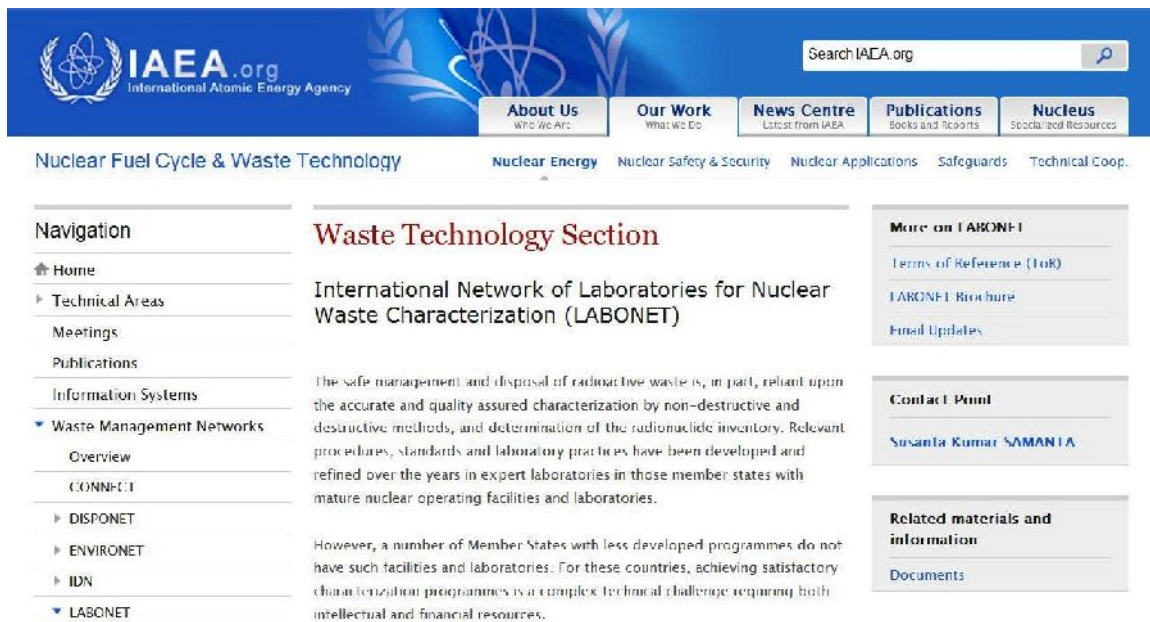


Fig. 3. IAEA LABONET Network (see web page: <http://www.iaea.org/OurWork/ST/NE/NEFW/WTS-Networks/LABONET/overview.html>)

## Peer review services

In addition to its TC programme, the Agency provides advisory services to Member States having relatively developed and mature radioactive waste management programmes. One particular area where the Agency has been actively involved is providing peer review services related to radioactive waste management at the request of Member States. By this mechanism, Member States can avail themselves of the services of an international panel of experts, appointed and coordinated by the Agency, to carry out an independent peer review of the activities according to the terms of reference established by the requesting party. The panel of experts carries out safety and technical reviews using internationally recognized standards, utilizing recognized professional experience and approaches to provide impartial review results.

Recent reviews performed in predisposal areas are as follows:

- *Long term strategy for waste management at ChNPP (Ukraine)*
- *Processing of high activity waste from accident at A1 NPP (Slovakia)*
- *Waste forms and packages for near surface disposal facilities (Lithuania)*

## SUMMARY

The International Atomic Energy Agency promotes safe and effective management of radioactive waste and has suitable programmes in place to serve the needs of Member States in this area. In support of these programmes the Waste Technology Section fosters technology transfer, promotes information exchange and cooperative research, as well as builds capacity in Member States to manage radioactive wastes, resulting both from the nuclear fuel cycle and nuclear applications. Technical assistance in predisposal area covers all of these activities and is delivered through established Agency mechanisms like publication of technical documents, coordinated research projects, technical cooperation projects, training, networks and peer review services.

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