Establishing a National System for Radioactive Waste Management

A PUBLICATION
WITHIN THE RADWASS PROGRAMME

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ESTABLISHING A
NATIONAL SYSTEM FOR
RADIOACTIVE WASTE MANAGEMENT
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Radioactive waste is produced during the generation of nuclear power and the use of radioactive materials in industry, research and medicine. The importance of the safe management of radioactive waste for the protection of human health and the environment has long been recognized, and considerable experience has been gained in this field.

The IAEA's Radioactive Waste Safety Standards (RADWASS) programme is aimed at establishing a coherent and comprehensive set of principles and standards for the safe management of waste and formulating the guidelines necessary for their application. This is accomplished within the IAEA Safety Series in an internally consistent set of documents that reflect an international consensus. The RADWASS publications will provide Member States with a comprehensive series of internationally agreed documents to assist in the derivation of, and to complement, national criteria, standards and practices.

The Safety Series scheme consists of a four-level hierarchy of publications — with a Safety Fundamentals document at the highest level, followed by Safety Standards, Safety Guides and Safety Practices at the other three levels. With respect to the RADWASS programme, the set of publications is currently undergoing in-depth review to ensure a harmonized approach throughout the Safety Series.

This Safety Standard specifies the key elements of a national framework for radioactive waste management, details the responsibilities of Member States, regulatory bodies and operators and describes other important features such as processes for safety and environmental impact assessment and for licensing. It is based on the principles set out in the Safety Fundamentals document and provides the basis for developing Safety Guides and Safety Practices that contain detailed guidance on its implementation.

This document has been developed through a series of consultants and Technical Committee meetings. It was reviewed by the International Radioactive Waste Management Advisory Committee (INWAC) and by Member States and was recommended for publication by an Extended INWAC. It was approved by the IAEA's Board of Governors in March 1995 for publication in the Safety Series.

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1. INTRODUCTION

BACKGROUND

101. Radioactive waste needs to be safely managed because it is potentially hazardous to human health and the environment. Each Member State needs to have a national framework that sets forth the necessary and appropriate requirements for radioactive waste management in that country. Because the nature and volume of radioactive waste from different sources vary greatly, the requirements for its safe management also vary greatly.

102. Safe radioactive waste management relies on the application of technology and resources in a regulated manner, in accordance with internationally agreed principles [1], so that the exposure of the public and workers to ionizing radiation is restricted and the environment is protected. Basic requirements on such safe management are provided in the RADWASS Safety Standards on predisposal, disposal, uranium and thorium mining and milling waste and decommissioning of nuclear facilities.

103. Experience shows that safe management of radioactive waste relies on:

(a) developing relevant laws and regulations and establishing or designating a regulatory body for radioactive waste management; and
(b) developing the necessary operational capability.

OBJECTIVE

104. The objective of this Safety Standard is to assist Member States in developing a national system for radioactive waste management, to identify the key responsibilities of the parties involved and to delineate essential features of such a system.

SCOPE

105. This Safety Standard sets forth the elements for establishing a national system that provides for the safe management of those radioactive materials defined to be radioactive waste by appropriate national authorities. It applies to the facilities involved in the management of this waste from generation through to disposal.

106. This Safety Standard is intended to cover the requirements necessary and appropriate for all situations involving radioactive waste management. It is designed
for complex situations, especially for solid, liquid and airborne radioactive waste resulting from the nuclear fuel cycle. For less complex situations, not all the requirements in this standard may be necessary or appropriate. Each Member State must decide the extent of application of the requirements to particular situations.

STRUCTURE

107. The main text of the Safety Standard is organized as follows:

(a) Section 2 sets out the main objective for radioactive waste management and the principles on which radioactive waste management policy and strategies should be based;
(b) Section 3 presents the basic components of a national framework for radioactive waste management;
(c) Section 4 outlines the responsibilities of the Member State, the regulatory body and the waste generators and operators of radioactive waste management facilities; and
(d) Section 5 describes important features of radioactive waste management.

108. The Annex, as taken from the RADWASS Safety Fundamentals document [1], describes the basic steps in radioactive waste management to provide a common understanding among users of RADWASS publications. The publication also contains a glossary.

2. OBJECTIVE AND PRINCIPLES OF RADIOACTIVE WASTE MANAGEMENT

201. The objective of radioactive waste management is to deal with radioactive waste in a manner that protects human health and the environment now and in the future without imposing undue burdens on future generations.

202. To meet the above objective, the following internationally agreed principles are detailed in the RADWASS Safety Fundamentals, together with supporting text:

Principle 1: Protection of human health

Radioactive waste shall be managed in such a way as to secure an acceptable level of protection for human health.
Principle 2: Protection of the environment

Radioactive waste shall be managed in such a way as to provide an acceptable level of protection of the environment.

Principle 3: Protection beyond national borders

Radioactive waste shall be managed in such a way as to assure that possible effects on human health and the environment beyond national borders will be taken into account.

Principle 4: Protection of future generations

Radioactive waste shall be managed in such a way that predicted impacts on the health of future generations will not be greater than relevant levels of impact that are acceptable today.

Principle 5: Burdens on future generations

Radioactive waste shall be managed in such a way that will not impose undue burdens on future generations.

Principle 6: National legal framework

Radioactive waste shall be managed within an appropriate national legal framework including clear allocation of responsibilities and provision for independent regulatory functions.

Principle 7: Control of radioactive waste generation

Generation of radioactive waste shall be kept to the minimum practicable.

Principle 8: Radioactive waste generation and management interdependencies

Interdependencies among all steps in radioactive waste generation and management shall be appropriately taken into account.

Principle 9: Safety of facilities

The safety of facilities for radioactive waste management shall be appropriately assured during their lifetime.
203. In the implementation of the above principles, the relevant recommendations of international bodies such as the IAEA and ICRP are typically taken into account. In relation to the radiological protection aspects of the principles, the recommendations of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS) [2] are relevant.

3. NATIONAL FRAMEWORK FOR RADIOACTIVE WASTE MANAGEMENT

POLICY

301. Member States in which radioactive waste exists shall have a national policy for the management of this waste in accordance with the objective and principles set out in Section 2. Such a policy does not need to be formalized in a single document nor is it necessary to assign responsibility for formulation of the entire policy to a single entity.

STRATEGIES

302. Member States shall have strategies to implement their national radioactive waste management policy. The development of these strategies will depend on national circumstances, structures and priorities and the diversity in types of radioactive waste.

SYSTEM

303. The objective of these strategies is to ensure that within the Member State the components of a comprehensive radioactive waste management system are established. This will include both an operational capability for dealing with the radioactive waste and an independent regulatory capability for controlling the way in which it is dealt with. For the operational capability appropriate facilities and operators are required. For the regulatory capability a Member State is required to have a legal framework and a regulatory body to enforce compliance with legal requirements.

304. The use of the term 'system' does not necessarily imply a single centralized system for the Member State. Rather it is the summation of all the individual
components, for example body of laws, regulatory organizations, operators, facilities, etc. that are required for the management of radioactive waste.

305. It is recognized that the extent to which the components of a national radioactive waste management system are developed will vary from country to country depending upon national needs. Parts of a national radioactive waste management system may be implemented by co-operation with other countries and international organizations.

306. The basic requirements of a radioactive waste management system are:

(a) identification of the parties involved in the different steps of radioactive waste management, including waste generators and their responsibilities;
(b) a rational set of safety, radiological and environmental protection objectives from which standards and criteria may be derived within the regulatory system;
(c) identification of existing and anticipated radioactive wastes, including their location, radionuclide content and other physical and chemical characteristics;
(d) control of radioactive waste generation;
(e) identification of available methods and facilities to process, store and dispose of radioactive waste on an appropriate time-scale;
(f) taking appropriately into account interdependencies among all steps in radioactive waste generation and management;
(g) appropriate research and development to support the operational and regulatory needs; and
(h) the funding structure and the allocation of resources that are essential for radioactive waste management, including decommissioning and, where appropriate, maintenance of repositories and post-closure surveillance.

307. Member States shall address needs for public information and consider issues related to public consultation with respect to the management of radioactive waste.

4. RESPONSIBILITIES ASSOCIATED WITH RADIOACTIVE WASTE MANAGEMENT

401. Safe radioactive waste management requires clear allocation of responsibilities to the parties involved. The overall responsibilities as described in this section cannot be delegated even if work is performed by others, for example by contractors.
RESPONSIBILITIES OF THE MEMBER STATE

Responsibility 1: To establish and implement a legal framework

402. Member States shall establish and implement a legal framework for the management of radioactive waste. This framework should be based on internationally agreed principles as set out in Section 2 and need not necessarily be designed solely for radioactive waste management.

403. The legal framework consists of the necessary laws and subsidiary legal requirements, for example regulations. The specific components of this framework will vary from country to country depending on the political structure, the governmental organizations involved, the national legislation, the regulatory practices, the types and amounts of radioactive waste, and the level of technical development.

404. Member States shall clearly allocate responsibilities to all parties involved in radioactive waste management. They may decide that the national government or the government of a subnational unit should take direct responsibility for some or all of the radioactive waste management activities.

405. The national government should take responsibility for international matters, concerning the policy and regulation of radioactive waste management.

406. To achieve safe management of radioactive waste, the legal framework shall provide for:

(a) safety, radiological and environmental protection objectives;
(b) a regulatory system, including licensing or other authorizations, as appropriate;
(c) an appropriate level of institutional control;
(d) enforcement of the legal requirements;
(e) definition and classification of radioactive waste [3–5];
(f) quality assurance;
(g) documentation and reporting;
(h) emergency planning; and
(i) appropriate public information and consultation.

Responsibility 2: To establish a regulatory body

407. Member States shall establish or designate a regulatory body that has the responsibility for carrying out the regulatory function with regard to safety and the protection of human health and the environment. Where the regulatory function is divided among several authorities or levels of government, Member States shall
ensure that the regulatory system is comprehensive and coherent. The regulatory body may be assisted by advisory bodies and experts in radiation protection and other specialized disciplines.

408. Member States shall take appropriate steps to ensure that the regulatory body is provided with adequate authority, competence and financial and human resources to fulfil the regulatory functions assigned to it. The regulatory body shall be empowered to enforce legal requirements related to all aspects of radioactive waste management, in co-operation with other government agencies or departments where appropriate. The regulatory body shall also be empowered to issue, amend, renew, suspend or cancel licences or authorizations or to recommend such actions to the government.

409. An important condition for the proper exercise of the regulatory function is its effective independence from operating organizations, designers, vendors and constructors involved in waste management activities. This is necessary so that regulatory judgements may be made, and enforcement actions taken, without pressure from interests that may compete with safety. The regulatory body may need to share sources of expertise, especially in countries with limited resources and a limited use of radionuclides resulting in the generation of radioactive waste. Regulatory and operational functions may be located in one organization, for example, if the government takes over responsibilities (see para. 404). In such cases, regulatory independence shall not be compromised.

410. The organizational structure and size of the regulatory body will typically take account of elements such as:

(a) the legal and administrative system of the Member State;
(b) the amounts and types of radioactive waste;
(c) the organization and structure of waste generators and operators of radioactive waste management facilities; and
(d) the need to ensure the independence of the regulatory body.

Responsibility 3: To define responsibilities of waste generators and operators of radioactive waste management facilities

411. Member States shall ensure that the role and responsibilities of waste generators and operators that process, transport, store or dispose of radioactive waste are defined. The responsibility for the safety of radioactive waste management activities shall be assigned to the waste generators and operators. These activities may be carried out by one operator, or by several operators in sequence. In the latter case, Member States shall ensure continuity of responsibilities.
Responsibility 4: To provide for adequate resources

412. Member States shall take appropriate steps to ensure that adequate financial, human and technical resources are available or will be provided to support the radioactive waste management system.

RESPONSIBILITIES OF THE REGULATORY BODY

Responsibility 5: To enforce compliance with legal requirements

413. It is the responsibility of the regulatory body to monitor and enforce compliance with the established legislative and statutory framework for safety and environmental protection. No other responsibility assigned to the regulatory body should jeopardize, or conflict with, this mission. In fulfilling this responsibility, the regulatory body shall implement the licensing process and in co-operation with other government agencies or departments shall, where appropriate:

(a) develop and update the rules, criteria, guidelines, etc. required to implement the legal framework;
(b) take appropriate steps to ensure that activities generating radioactive waste will not be started without provision for suitable and sufficient storage capacity on an appropriate time-scale until relevant disposal routes are available; and
(c) take appropriate steps to ensure that adequate records of radioactive waste management facilities or sites are maintained for an appropriate period of time.

Responsibility 6: To implement the licensing process

414. The regulatory body has the responsibility to review, approve or reject applications and to issue, amend, modify, suspend, cancel or otherwise act upon plans, licences or other authorizations for radioactive waste management activities or to recommend such actions to the government. Licences or other authorizations shall include clear, unambiguous, legally and technically enforceable requirements and conditions governing radioactive waste management activities.

415. In implementing the licensing process the regulatory body shall:

(a) review environmental impacts and safety;
(b) implement an inspection programme; and
(c) require operators to take corrective measures where necessary.
416. The regulatory body shall be satisfied that the approval of an application for a new licence or any amendment or cancellation of an existing licence is consistent with continued safe radioactive waste management.

**Responsibility 7: To advise the government**

417. The regulatory body shall, where appropriate, make recommendations to the relevant governmental authority regarding the development and implementation of national policy, strategies, laws and objectives to ensure the safe management of radioactive waste.

**RESPONSIBILITIES OF WASTE GENERATORS AND OPERATORS OF RADIOACTIVE WASTE MANAGEMENT FACILITIES**

**Responsibility 8: To manage radioactive waste safely**

418. The responsibility for the safety of radioactive waste management activities rests with the operators, who shall:

(a) perform safety and environmental impact assessments;
(b) ensure adequate protection of the workers, the general public and the environment;
(c) ensure that suitable staff, equipment, facilities, training and operating procedures are available to perform the safe radioactive waste management steps;
(d) establish and implement a quality assurance programme for the radioactive waste generated or its processing, storage and disposal;
(e) establish and keep records of appropriate information regarding the generation, processing, storage and disposal of radioactive waste, including an inventory of radioactive waste;
(f) provide surveillance and control as required by the regulatory body;
(g) collect, analyse and, as appropriate, share operational experience to ensure continued safety improvements; and
(h) conduct or otherwise ensure appropriate research and development to support operational needs.

419. Waste generators and operators of waste management facilities shall keep the generation of radioactive waste to the minimum practicable by suitable design, and operation and decommissioning of the facility. Interdependencies among all steps in radioactive waste generation and management shall be appropriately taken into account.
Responsibility 9: To identify an acceptable destination for the radioactive waste

420. Waste generators or operators of a facility dealing with radioactive waste are responsible for identifying, on an appropriate time-scale, a destination for their waste that is in accordance with the legal requirements and acceptable to the government or the regulatory body, and for seeking any necessary authorization. The operator may dispose of the radioactive waste in a legally approved manner, or may transfer it in an authorized manner to another operator for processing, storage or disposal.

Responsibility 10: To comply with legal requirements

421. Waste generators and operators of radioactive waste management facilities shall comply with the legal requirements imposed on them and demonstrate such compliance to the satisfaction of the regulatory body.

5. IMPORTANT FEATURES OF RADIOACTIVE WASTE MANAGEMENT

501. The radioactive waste management system includes a number of features in support of the aforementioned requirements. Some of the features important for safe radioactive waste management are detailed in this section.

THE LICENSING PROCESS

502. A licence or other type of authorization may apply to a class of operators or an individual operator, to an activity, site or facility. The licensing process follows a sequence that depends on the legal framework and the subject of the application. It may comprise the following steps: application, evaluation, issuance or refusal, and amendment, renewal, suspension or cancellation of existing licences. The procedures for each of these steps should be clearly defined. As appropriate, the licensing process may apply to preparatory field investigations, siting, design, construction, commissioning and operation as well as the decommissioning of facilities or closure of a repository.

503. With respect to radioactive waste management, the application for a licence should comprise:

(a) a demonstration of the required level of safety, including radiation protection of workers and the public, and protection of the environment, according to the legal framework;
(b) an assurance that the generation of radioactive waste in the facility is kept to the minimum practicable, taking appropriately into account interdependencies among all steps in radioactive waste generation and management;

(c) an assurance that any treatment and conditioning of radioactive waste will be compatible with the anticipated type and duration of the storage, and the need for retrievability of the radioactive waste from storage; and

(d) an assurance that account is taken of anticipated waste arisings, disposal options and safety considerations.

SAFETY AND ENVIRONMENTAL IMPACT ASSESSMENTS

504. Consistent with national regulatory requirements, a safety assessment and an environmental impact assessment should be prepared for new waste management facilities and practices as well as for significant modifications of existing facilities or practices. Such assessments aim to demonstrate compliance with national regulatory requirements and provide a basis for a regulatory authority to review and approve the facilities or practices. They should take account of the complexity of the respective facility or practice.

505. Assessments should be made to analyse and demonstrate the radiological and non-radiological safety under normal operation and also to assess the potential effects of incidents and accidents, according to national regulations. The assessments should demonstrate, where necessary, long term safety [6–9] in accordance with the principles set out in para. 202.

506. Assessments for normal operation should be made to analyse and demonstrate the radiological and non-radiological safety for all stages of the radioactive waste management process, in relation to the workers, the public and the environment. These assessments should be based on the design of the facility and the process description.

507. Assessments should also be made to identify, describe and analyse the potential non-radiological effects of radioactive waste management facilities on human beings, the environment (soil, water, air and non-human biota) and natural resources.

508. Assessments should also be made to identify various possible sequences of internal or external events that may lead to incidents or accidents and to evaluate their impacts for workers, the public and the environment. Such assessments should make use of appropriate modelling methods and data from available experience.

509. The assessments of the long term performance of a disposal facility should take account of the radionuclide content and physical and chemical characteristics of the
waste it is likely to contain, and of the effectiveness of barriers to be provided by the disposal system. The effectiveness of the natural barriers should be determined by site investigations. These assessments can only be carried out by the use of predictive models that should take into account and be based upon experimental data.

GENERATION AND MANAGEMENT OF RADIOACTIVE WASTE

510. In recognition of the interdependencies among all steps in radioactive waste generation and management, planning for activities that generate radioactive waste needs to take into account, as appropriate:

(a) the extent to which the radioactive waste can be kept to the minimum practicable, both in activity and volume; and
(b) the expected requirements for the radioactive waste management steps.

511. The various steps in radioactive waste management should be developed using an approach that addresses all safety aspects and needs, because decisions relating to a specific step in the management of radioactive waste may have significant consequences for other steps. An individual step, therefore, should not be considered in isolation because it can foreclose options or otherwise affect other waste management steps.

512. The successful approach to radioactive waste management is greatly assisted by interaction and dialogue between relevant parties.

SAFETY CULTURE

513. Safety culture refers to the dedication to safety and accountability of individuals and organizations engaged in the management of radioactive waste. Individuals and organizations responsible for radioactive waste management activities which may have safety implications should establish and implement policies and procedures that foster the growth of safety culture [10].

514. The primary responsibility for developing awareness of safety related matters rests with the senior management of all organizations. Policies and review procedures should be developed and implemented by all organizations engaged in the management of radioactive waste to ensure that correct practices are established and used and that an awareness of safety is created and maintained. Staff training programmes that emphasize the reasons behind safety practices and the importance of personal performance should be developed and implemented.
QUALITY ASSURANCE

515. Quality assurance should provide the necessary confidence that adequate measures are being taken to protect human health and the environment.

516. The operator's organizational structure should provide sufficient independence of the quality assurance function. The responsibilities and authority of personnel and organizations involved should be clearly delineated. Quality assurance applies to all radioactive waste management activities, especially those features important to safety. In particular, the quality assurance programme should ensure that waste packages meet the waste acceptance requirements.

517. The regulatory body should review the quality assurance programme of the operator and may identify quality assurance measures that have to be carried out independently of the operator.

RESEARCH AND DEVELOPMENT

518. Research and development work should be carried out in accordance with the size and needs of the radioactive waste management programme.

519. Where the long term performance of a system cannot be proven by direct observation, a research and development programme should be established to obtain the necessary information. Such a programme may be carried out by co-operation in international research and development programmes.

520. Lessons learned from national and international operating experience and research need to be considered by both the operating organization and the regulatory body in order to determine whether equipment, procedures, training or related safety requirements need to be modified.

DOCUMENTATION AND RECORDS

521. The regulatory body, the waste generators and the operators of radioactive waste management facilities should maintain documentation and records consistent with the legal requirements and their own needs. These records should be kept in a condition that will enable them to be consulted and understood later by people different from, and possibly without reference to, those who generated the records, for example in relation to waste disposal or decommissioning. This is particularly important in the case of computerized records. The regulatory body may choose to take responsibility for the long term retention of the above mentioned records.
522. Documentation and records should include relevant details of items such as:

(a) an inventory of radioactive waste, including origin, location, physical and chemical characteristics, and, as appropriate, a record of radioactive waste removed or discharged from a facility;
(b) site plans, engineering drawings, specifications and process descriptions;
(c) data resulting from quality assurance and quality control procedures and from operating activities;
(d) safety and environmental assessment methods and computer codes;
(e) results of safety and environmental assessments;
(f) effluent and environmental impact monitoring results;
(g) radioactive waste package identification; and
(h) disposal facility closure data.

STAFF TRAINING AND QUALIFICATION

523. The staff of the regulatory body and the operators need to have the necessary expertise. Appropriate staff training programmes should be established to secure the necessary competence of staff, to foster the necessary dedication to quality and safety, and to keep the staff up to date with changes in relevant technology and regulations. Such training programmes may be supplemented through bilateral agreements with other countries, through international organizations or by vendors of facilities.

EMERGENCY PLANNING

524. Where radioactive waste management activities have the potential to adversely affect human health and the environment through an accident, Member States need to provide for emergency planning and make such provisions as might be necessary to respond to an accident in that State [11].

INSTITUTIONAL CONTROL

525. Management of radioactive waste should, to the extent possible, not rely on long term institutional arrangements. However, institutional control may be required for an appropriate duration after closure of a repository, especially in the case of a near surface radioactive waste disposal facility, to:

(a) prevent intrusion into the repository;
(b) prevent removal of, or interference with, the radioactive waste;
(c) monitor the performance of the repository against the design criteria; and
(d) perform necessary remedial actions.

The control can be active (for example continuous monitoring, periodic inspection, maintenance or controlled access), or passive (for example permanent markers, land use restrictions).

526. The maximum duration of institutional control that the operator can take credit for in the safety assessment should be determined by the regulatory body.
REFERENCES


Annex

BASIC STEPS IN RADIOACTIVE WASTE MANAGEMENT

Effective management of radioactive waste considers the basic steps (shown schematically in Fig. A.1) in the radioactive waste management process as parts of a total system, from generation through disposal. Because decisions made in one step may foreclose certain alternatives in another step, the RADWASS programme emphasizes the importance of taking into account interdependencies among all steps during planning, design, construction, operation and decommissioning of radioactive waste management facilities.

This Annex describes the various steps in radioactive waste management in order to provide a common terminology and understanding among authors, reviewers and users of RADWASS documents. The considerations are intended to be general and to apply to the management of radioactive waste including that from mining and milling and environmental restoration programmes, that from nuclear power generation and that from medical and industrial application of radioactive materials. They apply to radioactive waste generated during the operational period as well as during the decommissioning of a facility. The applicability of these steps will vary depending on the types of radioactive waste.

The waste should be characterized in order to determine its physical, chemical and radiological properties, and to facilitate record keeping and acceptance of radioactive waste from one step to another. Characterization may be applied, for example, in order to segregate radioactive materials for exemption or for reuse or according to disposal methods or to assure compliance of waste packages with requirements for storage and disposal.

It should also be noted that transportation may be necessary between the radioactive waste management steps. Effective radioactive waste management should take the implications of transportation into account.

Storage of radioactive waste involves maintaining the radioactive waste such that: (1) isolation, environmental protection and monitoring are provided; and (2) actions involving, for example, treatment, conditioning and disposal are facilitated. In some cases, storage may be practised for primarily technical considerations, such as storage of radioactive waste containing mainly short lived radionuclides for decay and subsequent release within authorized limits, or storage of high level radioactive waste for thermal considerations prior to geological disposal. In other cases, storage may be practised for reasons of economics or policy.

Pretreatment of waste is the initial step in waste management that occurs after waste generation. It consists of, for example, collection, segregation, chemical adjustment and decontamination and may include a period of interim storage. This initial step is extremely important because it provides in many cases the best opportunity to segregate waste streams, for example, for recycling within the process or for dis-
posal as ordinary non-radioactive waste when the quantities of radioactive materials they contain are exempt from regulatory controls. It also provides the opportunity to segregate radioactive waste, for example, for near surface or geological disposal.

Treatment of radioactive waste includes those operations intended to improve safety or economy by changing the characteristics of the radioactive waste. The basic treatment concepts are volume reduction, radionuclide removal and change of composition. Examples of such operations are: incineration of combustible waste or compaction of dry solid waste (volume reduction); evaporation, filtration or ion exchange of liquid waste streams (radionuclide removal); and precipitation or flocculation of chemical species (change of composition). Often several of these processes are used in combination to provide effective decontamination of a liquid waste stream. This may lead to several types of secondary radioactive waste to be managed (contaminated filters, spent resins, sludges).

Conditioning of radioactive waste involves those operations that transform radioactive waste into a form suitable for handling, transportation, storage and disposal. The operations may include immobilization of radioactive waste, placing the waste into containers and providing additional packaging. Common immobilization methods include solidification of low and intermediate level liquid radioactive waste, for example in cement or bitumen, and vitrification of high level liquid radioactive waste in a glass matrix. Immobilized waste, in turn, may be packaged in containers ranging from common 200 litre steel drums to highly engineered thick-walled containers, depending on the nature of the radionuclides and their concentrations. In many instances, treatment and conditioning take place in close conjunction with one another.

Disposal is the final step in the radioactive waste management system. It consists mainly of the emplacement of radioactive waste in a disposal facility with reasonable assurance for safety, without the intention of retrieval and without reliance on long term surveillance and maintenance. This safety is mainly achieved by concentration and containment which involves the isolation of suitably conditioned radioactive waste in a disposal facility. Isolation is attained by placing barriers around the radioactive waste in order to restrict the release of radionuclides into the environment. The barriers can be either natural or engineered and an isolation system can consist of one or more barriers. A system of multiple barriers gives greater assurance of isolation and helps ensure that any release of radionuclides to the environment will occur at an acceptably low rate. Barriers can either provide absolute containment for a period of time, such as the metal wall of a container, or may retard the release of radioactive materials to the environment, such as a backfill or host rock with high sorption capability. During the period when the radioactive waste is contained by the system of barriers, the radionuclides in the waste will decay. The barrier system is designed according to the disposal option chosen and the radioactive waste forms involved.

Although it is planned to dispose of most types of radioactive waste by concentration and containment, disposal may also comprise the discharge of effluents
(for example, liquid and gaseous waste) into the environment within authorized limits, with subsequent dispersion. For all practical purposes this is an irreversible action and is considered suitable only for limited amounts of specific radioactive waste.

\[ \text{Waste and materials} \]
\[ \text{Pretreatment} \]
\[ \text{Exempt waste and material} \]
\[ \text{Treatment} \]
\[ \text{Radioactive material (for reuse/recycle)} \]
\[ \text{Conditioning} \]
\[ \text{Disposal} \]

**FIG. A.1. Basic steps in radioactive waste management.**
*Characterization, storage and transportation of waste and materials may take place between and within the basic radioactive waste management steps. The applicability of these steps will vary depending on the types of radioactive waste.*
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GLOSSARY

**accident.** Any unintended event, including operating errors, equipment failures or other mishaps, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.

**authorization.** The granting by a regulatory body of written permission for an operator or a class of operators to perform specified activities. Types of authorization include licences, permits, certifications and notifications.

**closure (permanent).** The term closure refers to the status of, or an action directed at, a disposal facility at the end of its operating life. A disposal facility is placed into permanent closure usually after completion of waste emplacement, by covering for a near surface disposal facility, by backfilling and/or sealing of a geological repository and the passages leading to it, and termination and completion of activities in any associated structures.

**conditioning.** Those operations that produce a waste package suitable for handling, transportation, storage and/or disposal. Conditioning may include the conversion of the waste to a solid waste form, enclosure of the waste in containers, and, if necessary, providing an overpack.

**decommissioning.** Actions taken at the end of the useful life of a nuclear facility in retiring it from service with adequate regard for the health and safety of workers and members of the public and protection of the environment. The ultimate goal of decommissioning is unrestricted release or use of the site. The time period to achieve this goal may range from a few to several hundred years. Subject to national legal and regulatory requirements, a nuclear facility or its remaining parts may also be considered decommissioned if it is incorporated into a new or existing facility, or even if the site in which it is located is still under regulatory or institutional control. This definition does not apply to some nuclear facilities used for mining and milling of radioactive materials or the disposal of radioactive waste.

**disposal.** The emplacement of waste in an approved, specified facility (for example, near surface or geological repository) without the intention of retrieval. Disposal may also include the approved direct discharge of effluents (for example, liquid and gaseous wastes) into the environment with subsequent dispersion.

**disposal, geological.** Isolation of radioactive waste, using a system of engineered and natural barriers at depths up to several hundred metres in a geologically
stable formation. Typical plans call for disposal of long lived and high level wastes in geological formations.

disposal, near surface. Disposal of waste, with or without engineered barriers, on or below the ground surface where the final protective covering is of the order of a few metres thick, or in caverns a few tens of metres below the Earth’s surface. Typically short lived, low and intermediate level wastes are disposed of in this manner. This term replaces ‘shallow land/ground disposal’.

fuel cycle (nuclear). All operations associated with the production of nuclear energy, including mining, milling, processing and enrichment of uranium or thorium; manufacture of nuclear fuel; operation of nuclear reactors; reprocessing of nuclear fuel; decommissioning; and any activity for radioactive waste management and any research or development activity related to any of the foregoing.

incident. A technical event or anomaly which, although not directly or immediately affecting safety, is liable to lead to subsequent re-evaluation of safety provisions.

institutional control. Control of a waste site (for example, disposal site) by an authority or institution designated under the laws of a country or state. This control may be active (monitoring, surveillance, remedial work) or passive (land use control) and may be a factor in the design of a nuclear facility (for example, near surface disposal facility).

licence. A formal, legally prescribed document issued by the regulatory body to perform specified activities related to the siting, design, construction, commissioning, operation, decommissioning of a nuclear facility, closure of a disposal facility, closeout of a mining and mill tailings site, or institutional control. A licence may be specific (i.e. issued to an individual person or entity) or general (i.e. issued to a class of persons or activities). (See also authorization.)

long term. In radioactive waste disposal, refers to periods of time which exceed the time during which active institutional control can be expected to last.

monitoring. The measurement of radiological or non-radiological parameters for reasons related to the assessment or control of exposure and the interpretation of such measurements. Monitoring can be continuous or non-continuous.

operator (or operating organization). In waste management, the organization (and its contractors) which performs activities to select and investigate the suitability of a site for a nuclear facility, and/or undertakes to design, construct, commis-
sion, operate and decommission such a facility. This term is preferred to ‘implementing organization’ which appeared in earlier literature.

**pretreatment.** Any or all the operations prior to waste treatment, such as:

- collection
- segregation
- chemical adjustment
- decontamination.

**quality assurance.** All those planned and systematic actions necessary to provide adequate confidence that an item, process or service will satisfy given requirements for quality, for example, those specified in a licence.

**regulatory body.** An authority or a system of authorities designated by the government of a Member State as having legal authority for conducting the regulatory process, including issuing licences or authorizations, and thereby for regulating the siting, design, construction, commissioning, operation, closure, closeout, decommissioning and, if required, subsequent institutional control of the nuclear facilities (for example, near surface repository) or specific aspects thereof. Such authority may be an existing organization in the field of nuclear related health and safety, mining safety or environmental protection, which is empowered with the appropriate legal authority.

**repository.** A nuclear facility (for example, geological repository) where waste is emplaced for disposal. Future retrieval of waste from the repository is not intended. (See also disposal).

**treatment.** Operations intended to benefit safety and/or economy by changing the characteristics of the waste. Three basic treatment objectives are:

(a) volume reduction
(b) removal of radionuclides from the waste
(c) change of composition.

After treatment, the waste may or may not be immobilized to achieve an appropriate waste form.

**waste, exempt.** In the context of radioactive waste management, waste that is released from nuclear regulatory control in accordance with clearance levels, because the associated radiological hazards are considered negligible. The designation may be in terms of activity concentration and/or total activity and may include a specification of the type, chemical/physical form, mass or volume of waste.
waste management, radioactive. All activities, administrative and operational, that are involved in the handling, pretreatment, treatment, conditioning, storage and disposal of waste from a nuclear facility. Transportation is taken into account.

waste, radioactive. For legal and regulatory purposes, radioactive waste may be defined as material that contains, or is contaminated with, radionuclides at concentrations or activities greater than clearance levels as established by the regulatory body, and for which no use is foreseen. (It should be recognized that this definition is purely for regulatory purposes, and that material with activity concentrations equal to or less than clearance levels is radioactive from a physical viewpoint — although the associated radiological hazards are considered negligible.)

waste generator. The operating organization of the facility where the waste is generated. (See also operator.)

waste processing. Any operation that changes the characteristics of a waste, including waste pretreatment, treatment and conditioning.
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Consultants Meetings

Vienna, Austria: 18–22 November 1991
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RADWASS Standing Technical Committee Meetings

Vienna, Austria: 9–13 March 1992
Vienna, Austria: 22–26 February 1993
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