

**RC-17**

**Radiation Protection in Waste Management and Disposal  
Implementing the Joint Convention on the Safety of Spent Fuel Management  
and on the Safety of Radioactive Waste Management**

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**Abstract:** Waste containing or contaminated with radionuclides arises from a number of activities involving the use of radioactive materials, such as the operation and decommissioning of nuclear facilities, the application of radionuclides in industry, medicine and research, the remediation of sites affected by radioactive residues from various operations or from accidents, and the processing of raw materials containing naturally occurring radionuclides. The nature of this waste is likely to be such that its safe management must take into account radiation safety considerations. 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. In addition the safe management of spent fuel and radioactive waste generated by nuclear power and fuel cycle plants operation is a key issue for the use of nuclear energy. The need of ensuring safety in dealing with radioactive materials is of importance for all the countries involved in such activities, even if they do not have or plan nuclear industrial programs. By that reason was promoted the *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention)* entered into force on 18 June 2001, being implemented at the present time by 46 countries.

**1. - Radiation Safety Objectives – Principles**

As it is expressed in the IAEA Safety Fundamentals SF -1 principles the safety objective is to protect people and the environment from harmful effects of ionizing radiation.

This objective of protecting people — individually and collectively — and the environment has to be achieved without unduly limiting the operation of facilities or the conduct of activities that give rise to radiation risks. To ensure that facilities are operated and activities conducted so as to achieve the highest standards of safety that can reasonably be achieved, measures have to be taken:

- (a) To control the radiation exposure of people and the release of radioactive material to the environment;
- (b) To restrict the likelihood of events that might lead to a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation;
- (c) To mitigate the consequences of such events if they were to occur.

The fundamental safety objective applies for all facilities and activities and for all stages over the lifetime of a facility or radiation source, including planning, siting, design, manufacturing, construction, commissioning and operation, as well as decommissioning and closure. This includes the associated transport of radioactive material and management of radioactive waste.

Ten safety principles have been formulated, on the basis of which safety requirements are developed and safety measures are to be implemented in order to achieve the fundamental safety

objective. The safety principles form a set that is applicable in its entirety; although in practice different principles may be more or less important in relation to particular circumstances, the appropriate application of all relevant principles is required.

**Principle 1: Responsibility for safety** The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks.

**Principle 2: Role of government** An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained.

**Principle 3: Leadership and management for safety** Effective leadership and management for safety must be established and sustained in organizations concerned with, and facilities and activities that give rise to, radiation risks.

**Principle 4: Justification of facilities and activities** Facilities and activities that give rise to radiation risks must yield an overall benefit.

**Principle 5: Optimization of protection** must be optimized to provide the highest level of safety that can reasonably be achieved.

**Principle 6: Limitation of risks to individuals** Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm.

**Principle 7: Protection of present and future generations** People and the environment, present and future, must be protected against radiation risks.

**Principle 8: Prevention of accidents** All practical efforts must be made to prevent and mitigate nuclear or radiation accidents.

**Principle 9: Emergency preparedness and response** Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents. **Principle 10: Protective actions to reduce existing or unregulated radiation risks** Protective actions to reduce existing or unregulated radiation risks must be justified and optimized.

## **2.- Radiation Protection in Waste Management**

The general principles of managing radioactive waste in a safe manner have been set out in the Fundamentals Safety Principles.

The waste management requires design and operational measures to provide for the protection of human health and the environment, both during operation of the pre disposal and disposal facility and following its closure. “Disposal” refers to the emplacement of waste in a facility without the intention of retrieval. The term “disposal facility” refers to the emplaced waste plus the engineered barriers and structures. Predisposal management of radioactive waste, as the term is used in the Safety Requirements publications, comprises all waste management steps including generation, processing (pretreatment, treatment, conditioning, storage and transport) prior to disposal.

It could be potential radiological impacts during operation of waste management and the exposures may arise from: routine and abnormal operations at the facility (i.e. unplanned incidents) for example: from physical damage to waste packages, leakage, fire or explosions. Exposures could arise due to: direct exposure to radiation from the waste/waste packages and from any radioactive releases from the packages or the disposal facility into the surrounding environment.

These situations could give rise to radiation exposure to: workers and/or members of the public. Such exposures can be limited and controlled using standard radiation protection measures, such as: limiting the time of exposure, controlling the accessible distance to the source, providing shielding of the source, ensuring containment of the waste material, by controlling the form and contents of the waste package, and establishing suitable facility operating procedures.

The IAEA Safety Requirements specify radiation dose and risk limits and constraints for workers and members of the public are applicable to the assessment of releases from both routine and non-routine operations.

Potential radiological impacts may arise due to gradual (continuous or episodic) processes, such as natural degradation of barriers, or from disruptive events including human intrusion, which may affect the containment and isolation of the waste from the accessible environment.

The objective and criteria for radiation protection during the operational period of waste management are the same as for any nuclear facility, and are as required by the Basic Safety Standards.

During the operational period the **objective** must be:

- The radiation doses to workers and members of the public exposed as a result of operations at the disposal facility shall be as low as reasonably achievable, social and economic factors being taken into account, and
- The exposures of individuals shall be kept within applicable dose limits and constraints.

The **criteria** must be:

(a) the occupational exposure of any worker shall be controlled so that the following limits are not exceeded:

– an effective dose of **20 mSv** per year averaged over five consecutive years,

– an effective dose of **50 mSv** in any single year.

(b) the estimated average doses to the relevant critical groups of members of the public from all practices shall not exceed the following limit:

– an effective dose of **1 mSv** in a year.

To comply with the dose limit, a waste disposal facility (which constitutes a single source) shall be designed so that the estimated average dose to the relevant critical groups of members of the public, who may be exposed as a result of the facility and its operation, satisfies a **dose constraint** of not more than **0.3 mSv per year**. This corresponds to a risk of the order of 10-5 per year.

In radiological protection terms: the source (e.g. disposal facility) is under control, releases can be verified, and exposures to workers and the public controlled.

Optimization of protection must be considered at every stage of the development of the disposal facility

- design,
- planning of operations
- closure

in order to ensure that radiation doses to workers will be as low as reasonably achievable.

Important and relevant considerations from a safety point of view include: the separation of construction activities from waste emplacement activities, the use of remote handling and shielded equipment for waste emplacement, the control of working environments, reducing the

potential for accidents and their consequences, and the minimization of maintenance requirements in radiation and contamination areas.

Relevant considerations in the event of operational accidents involving a breach of packaging include: the waste packaging, the form and content of the waste, the control of the content and contamination on waste packages, and equipment and monitoring of the disposal facility ventilation exhaust air and drainage water.

Doses and risks associated with the transport of radioactive waste to the disposal facility should be managed in the same way as those associated with the transport of other radioactive materials

The primary design goal of a radioactive waste disposal facility is to provide for the protection of human health and the environment in the long term, after the facility is closed and until the time when the associated radiological hazard will reach an insignificant level.

The exposure of humans may occur: due to slow degradation of barriers, slow natural processes and also following discreet events that may alter the disposal system barriers or lead to short term release of radionuclides

Radioactive waste disposal facilities shall be sited, designed, constructed, operated and closed so that protection in the long term is optimized, social and economic factors being taken into account, and a reasonable assurance provided that doses or risks in the long term will not exceed the dose or risk constraints for members of the public.

The criteria for dose limit for members of the public from all sources is an effective dose of 1 mSv in a year, and this or its risk equivalent should be considered as criteria not to be exceeded in the future.

For any given exposure mechanism leading to a dose into the future, the critical group will be somewhat hypothetical because human habits may change significantly, even over a short period of time. Exposure scenarios for the critical group should be postulated on the basis of an appropriately conservative analysis of events and processes that will not lead to doses to the exposed individuals being underestimated.

The estimated average dose or risk to members of the public, who may be exposed as a result of the disposal facilities in the future, shall not exceed a dose constraint of 0.3 mSv in a year or a risk constraint of the order of  $10^{-5}$  per year.

The constrained optimization process is clearly facility, site and programme specific. These criteria are applicable to exposures resulting from gradual processes.

Situations in which exposure could arise as a result of the occurrence of unlikely events that affect the repository, i.e. events, which low associated probabilities, should also be considered

In this context, optimization of protection is: a judgmental process with social and economic factors being taken into account, and should be conducted in a structured, but essentially qualitative way, supported by quantitative analysis as appropriate.

In general, protection can be considered optimized if: due attention has been paid to the long term safety implications of various design options at each step during development of the disposal system; the assessed doses and/or risks resulting from the generally expected range of natural evolution of the disposal system do not exceed the appropriate constraint; the probability of unlikely events that might disturb the performance such as to give rise to higher doses or risks has been reasonably reduced by siting, design, or institutional control and the design, construction, operational programmes and closure have been subjected to a quality management programme.

Potential Exposures must be taken into account in evaluating the overall safety of a disposal facility. The control of risk from potential exposures can be achieved by increasing protection in

a manner that: decreases the probabilities of occurrence of the events; or decreases the consequences, e.g. doses from the events if they occur (this is called mitigation).

### **3. - Roles and Responsibilities concerning the Safety of waste management**

- ***Regulatory Body***

The government is responsible for setting national policies and strategies with respect to radioactive waste management and for providing the legal framework required to implement the policies and strategies. The waste management policies and strategies should address the type of storage facilities appropriate for the national waste inventory.

The government should consult stakeholders involved in or affected by waste management activities on matters relating to the development of policy and strategy that affect the storage of radioactive waste.

To facilitate effective and safe predisposal management of radioactive waste, the regulatory body ensures that an appropriate waste classification scheme is established in accordance with national programmes and requirements and international recommendations. To protect human health and the environment, the regulatory body establishes requirements and criteria pertaining to the safety of facilities, processes and operations for predisposal management of radioactive waste. These include requirements related to handling, transport and storage as well as known or likely requirements associated with the acceptance of waste packages for disposal.

The regulatory body also establishes the basic requirements for protecting workers and member of the public and also limits and conditions for the removal of controls from materials containing radionuclides and provides guidance for the authorized use of materials and for the authorized discharge of liquids and gases containing radionuclides. The regulatory body also considers establishing criteria for the clearance of materials. Such limits, conditions and criteria shall ensure the protection of human health and the environment and shall take account of international recommendations.

For predisposal facilities and activities, as in all areas of its statutory obligations, the regulatory body is required to act within the national legal framework. Specific responsibilities may include contributing to the technical input towards the definition of policies, safety principles and associated criteria and to establish regulations or conditions to serve as the basis of its regulatory actions. The regulatory body should provide guidance to operators on requirements relating to the predisposal management of radioactive waste and clearance of material from regulatory control.

Recognizing that there is a wide range of potential hazards depending on the nature of the facility, a graded regulatory approach should be implemented that is commensurate with the level of risk. Authorization in the form of registration may be sufficient for many small operations involving very low activity waste. In the case of facilities involving higher activity waste, licensing is likely to be necessary to ensure the required level of control.

The regulatory body should prepare decommissioning guidelines (that may also be applied to predisposal waste management facilities). The operator should utilise such guidelines when developing design options and operating practices in order to facilitate future decommissioning activities.

Since waste may be stored between predisposal steps and prior to its disposal for extended periods of time, the regulatory body should ensure that the operator provides the necessary human, technical, and financial resources for the period of the storage facility lifecycle.

The regulatory body ensures that relevant documents and records are prepared, kept for an agreed time and maintained to a specified quality. It shall ensure that appropriate parties are responsible for this work.

The regulatory body should periodically verify key aspects of the predisposal operations such as records, inventories, material transfer records, compliance with package acceptance criteria, facility maintenance, surveillance, and monitoring. This may be carried out, for example, by

routine inspections of the predisposal facility and formal audits of the operator's documentation. The regulatory body should ensure that necessary records are prepared and maintained for an appropriate period of time.

The regulatory body should develop regulations and provide guidance to the various types of operators involved in the predisposal waste management. The guidance should be specific to the type of facility encountered, from the smallest (e.g. laboratory) to the largest type of facility (e.g. high-level waste vitrification facility).

- ***Waste Management Operator***

Generators of radioactive waste, including organizations carrying out decommissioning activities, and the operators of radioactive waste management facilities are considered to be engaged in predisposal management of radioactive waste. In the context of these Modules, they are referred to as 'operator(s)'.

In order to provide an adequate level of safety, the operator shall perform safety and environmental impact assessments; shall prepare and implement appropriate safety procedures; shall apply good engineering practice; shall ensure that staff are trained, qualified and competent; shall establish and implement a quality assurance programme; and shall keep records as required in accordance with the license conditions and applicable regulations.

The operator is responsible for the safety of all activities associated with predisposal management of radioactive waste throughout the lifetime of the facility (including decommissioning), and for the development and implementation of the programs and procedures necessary to ensure safety. In line with the graded approach, the programs and procedures necessary to ensure safety will generally be less extensive for the operator of a small facility.

The operator shall identify an acceptable destination for the radioactive waste and shall ensure that radioactive waste is transported safely and in accordance with transport requirements. The operator is responsible for tracking waste entering and leaving a facility and also for tracking the current inventory. The operation needs to develop and maintain operating procedures in order to ensure regulatory criteria and licensing requirements are met.

The responsibilities of the operator will depend upon the type and extent of the operation. The information provided by a small operator to address the aforementioned elements may be much less extensive compared with a large operator. Not all of the items listed above may apply to both large and small operators. For example, a small operator might not be expected to go through a siting process.

The operator is responsible for assessments to determine acceptable discharges from the facility and also for documentation of the discharges.

Unless otherwise required by the regulatory body, the operator shall establish and maintain decommissioning plans which are commensurate with the type and status of the facility. The initial decommissioning plan shall be established in the design phase of the facility.

The operator shall establish and maintain emergency planning commensurate with the hazards associated with the predisposal management of radioactive waste and the decommissioning activities, and shall report incidents significant to safety to the regulatory body in a timely manner.

The operator may delegate any work associated with the aforementioned responsibilities to other organizations but shall retain overall responsibility and control. A mechanism for providing adequate financial resources shall be established to cover the costs of radioactive waste management and, in particular, the cost of decommissioning. It shall be put in place before operation and shall be updated, as necessary.

Consideration shall also be given to providing the necessary financial resources in the event of premature shutdown of the facility.

At the completion of decommissioning, and before the operator can be relieved of further responsibility for the facility or site in accordance with the national legal framework, the operator shall provide to the regulatory body such information as may be required.

#### **4.- Conclusion**

Facilities and activities for management of radioactive waste, including decommissioning activities, shall be subject to safety and environmental impact assessments in order to demonstrate that they are adequately safe and, more specifically, that they will be in compliance with safety requirements established by the regulatory body.

Safety assessment is an iterative process. The results of the safety and environmental impact assessments shall be used to bring appropriate safety related improvements to predisposal waste management activities and decommissioning activities in order to reduce the likelihood of incidents or accidents and to identify key safety features required to mitigate their consequences should they occur.

These safety and environmental impact assessments shall address the facility's structures, systems and components, the waste to be processed and all associated operational work activities, and shall encompass both normal operation and anticipated incidents and accidents. In the latter case, the safety and environmental impact assessments shall demonstrate that appropriate measures have been taken to prevent incidents or accidents and that consequences would be mitigated should an incident or accident occur.

The extent and detail of the safety and environmental impact assessments shall be commensurate with the complexity and the hazard associated with the facility or operation.

#### **5. - Implementing the Joint Convention on the Safety of Spent Fuel Management and on Safety of Radioactive Waste Management - JC**

The *objective* of being contracting part and to implement the JC is:

To achieve and maintain a high degree of safety worldwide in spent fuel and radioactive waste management, to ensure that there are effective defenses against potential hazards so that individuals, society and the environment are protected now and in the future and to prevent accidents and mitigate their consequences should they occur.

The *nature* of the JC is:

A legally binding agreement between Contracting Parties; the first international binding legislation in the area of radioactive waste management. There are at the present time 46 contracting parties.

The technical basis for the JC is provided by the IAEA Fundamental Safety Principles.

It is an "Incentive" convention and No fixed penalties. It is intended to stimulate improvement in safety. Its Articles are "targets" – all cannot necessarily be met immediately and Nuclear Safety Convention is a "sister" Convention

The *scope of application* includes:

Waste and spent fuel from the operation of nuclear reactors, waste from use of radionuclides in medicine and industry, spent sealed sources, discharges from regulated nuclear facilities and waste from mining and processing of uranium and does not include (unless the Contracting Party declares it) spent fuel undergoing reprocessing, waste containing Norm that does not originate from the nuclear fuel cycle and spent fuel or radioactive waste within military or defence programmes.

### *Who is the Joint Convention intended for?*

Its scope is wide – it covers all types of waste and all countries generate some radioactive waste. Therefore, unlike the Nuclear Safety Convention, the Joint Convention is relevant and potentially useful to *all States*.

### *Articles*

There are 44 Articles altogether, divided into four groups: Technical, Political, Reporting and Procedural articles.

### Reporting requirements

Each Contracting Party shall submit a National Report to each review meeting which shall address the measures taken to implement each obligation of the Convention.

The National Report shall : address spent fuel and waste management policy and practices; address criteria used to define and categorize radioactive waste; include a listing of national spent fuel and waste management facilities; include an inventory of spent fuel and waste (subject to the Convention) and include a listing of facilities being decommissioned.

At each Review meeting National Reports will be critically reviewed (in Country Groups) and a Summary Report of the Review Meeting will be prepared – addressing the issues discussed and the conclusions reached. Next Third Review Meeting will be carried out in Vienna from 11 to 22 May 2009.

### Expected *outcomes* of the Joint Convention implementation process

- Gradual and sustained improvement in safety worldwide related to radioactive waste
- Improved unification/harmonization worldwide of safety policies and provisions related to waste management
- Resolution of commonly experienced waste problems
- Normalization of international arrangements for movement of waste (and disused sources) between countries
- Towards common safety criteria and definitions in the waste area
- Improved public confidence in national arrangements and provisions for spent fuel and radioactive waste management

### **6. - Conclusion**

To implement the JC generates benefits for a country from becoming a Contracting Party to the Joint Convention. Improvements in safety as an outcome of the review process are achieved; gain in knowledge through information exchange; improved credibility because of involvement in an international convention on safety; support in cases of malpractice in neighbouring States; greater influence in a regional context; possible technical assistance from other Contracting Parties and evidence of an open and transparent national approach.

### **7. – Bibliography**

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