Western European
WENRA WGWD
Nuclear Regulators Association

Umbrella Document

Interfaces and Interdependencies

Supplementary Report of the
Working Group on Waste and Decommissioning (WGWD)
Aug 2017

Table of Contents

		Executive Summary	4
		WENRA Terms of Reference	5
1		Introduction	7
1.1		Background	7
1.2		Scope and Objectives	9
1.3		Structure	9
2		General Considerations	11
2.1		Overarching Responsibilities	11
2.2		License Holder Responsibilities	12
2.3		Single-Case Countries	13
2.4		Securing Financial Funding	13
2.5		Other Licensing Regimes	13
2.6		NORM and Post-Accident Waste Management	14
3		Interfaces and Interdependencies between the WGWD reports	15
3.1		Overall Considerations	16
		- Knowledge Management	16
		- Clearance	16
		- Transports	17
		- Secondary Waste Generation	17
3.2		Report on Waste and Spent Fuel Storage Safety Reference Levels	18
		- Extended Periods of Storage	18
3.3		Report on Decommissioning Safety Reference Levels	19
		- Decommissioning as Part of Facility Planning	19
		- Waste Management Starts at Decommissioning	19

3.4		Report on Radioactive Waste Disposal Safety Reference Levels	**20**
		- Post-Closure Safety and Knowledge Management	**20**
3.5		Report on Radioactive Waste Treatment and Conditioning Safety Reference Levels	**21**
Appendix		References	**23**

Preface

The Working Group on Waste and Decommissioning was established by the directors of major western European nuclear regulators in 2002. I started to represent Switzerland in this working group in 2004. I can well remember my first attendance to a group meeting which took place in the early summer in Ljubljana. At the time, I did not entertain the idea that I would become the chair of the group for more than 10 years. In serving as chair I could benefit from fundamental discussions which took place in the early years under the chairpersonships of Jeremie Averoux and Peter Lietava. It was these discussions which have made the progress of the group possible. Progress in this sense not only means establishing a consistent set of requirements for the back end of the nuclear fuel cycle, i.e. waste management and decommissioning, but also establishing a procedure by which it is ensured that these requirements are implemented in the regulatory systems of all WENRA member states in due time.

Details on this unique process can be found in part III of both the storage and the decommissioning report, and will be added to the reports on disposal and waste processing as soon as these exercises are finished.

There are, however, some considerations which could not be boiled down to indicative requirements such as safety reference levels but which should receive high attention. The collation of these considerations is the purpose of this report which (for obvious reasons) is in a different format.

It's now just a little more than 5 years until my retirement age, and this may be the last new WGWD report to be published under my chairmanship. I would like to take this opportunity to thank all present and previous members of the WGWD for their enthusiasm and support and the many working hours they spent on our subjects. I include in my thanks their bosses who supported their engagement in WGWD work and approved their travelling budget.

Finally I take the opportunity to write down as few as five personal impressions/theses which should by no means be interpreted as the agreed opinion of all WGWD members! They are purely personal remarks of someone who has continuously been working in the nuclear field since the early '80s, most of the time in waste management including reprocessing.

I. **Existing radioactive waste is always a legacy**; there is no way to avoid its responsible management. This is absolutely independent of the nuclear future of a country. Any opposition to progressing in waste management for whatever reasons is inappropriate.
II. **There is no good or bad quality of radioactive waste!** I have often encountered very strange categorizations of "good" radioactive waste, such as institutional waste from medical applications and "bad" radioactive waste such as waste from commercial NPP operation. Some people tend to accept real doses from the first but are horrified by only a few mikroSievert from the latter. For any further consideration please refer to I.

III. **The only "better" radioactive waste is the one that is not produced at all.** In other words the use of the first tier of the waste hierarchy. If one principle were to be considered missing from the reports of the WGWD it is *avoiding the generation of radioactive waste*. The reason why this is very difficult to handle for our working group is that the subject needs to be considered as early as the design phase of nuclear installations. Hence the WGWD most probably is not the right place to discuss this matter. The greatest benefit from early consideration of this issue could be derived in nuclear evolving countries, who will be well advised to learn from earlier mistakes in countries where the nuclear star is already falling.

IV. **To work with radioactive waste means to accumulate real worker doses.** It is a prominent duty for any waste owner to plan handling, processing and transport activities looking well into the future. In other words they should do the appropriate things in the first attempt avoiding any unnecessary reconditioning, repacking, etc.

On the other hand it should "go without saying" (this was a favourite phrase of my highly appreciated former colleague Stig Wingefors) that any competent and comprehensive regulatory system should include corresponding guidelines on any relevant waste management operation even if the real operation of a repository project is not anticipated in the near future.

V. In many countries most of the public interest is devoted to the operation (or non-operation) of NPPs and the progress (or disrupting the progress) of disposal projects. **Waste management operations which are executed today often receive less attention than they deserve**. Unfortunately this is well reflected in the corresponding budgets and staffing of quite a few (but definitely not all) operators as well as some regulators.

I would be very happy if these statements would be considered as a small piece of knowledge transfer to the next generation of nuclear professionals as well as a starting point for more interesting and fruitful discussions among colleagues and with stakeholders.

Stefan Theis Brugg, August 2017

Executive Summary

The Western European Nuclear Regulators' Association (WENRA) is an international body made up of the Heads and senior staff members of Nuclear Regulatory Authorities of European countries with nuclear power plants. The main objectives of WENRA are to develop a common approach to nuclear safety, to provide an independent capability to examine nuclear safety and to provide a network for chief nuclear safety regulators in Europe to exchange experience and discuss significant safety issues.

In the past years, the Working Group on Waste and Decommissioning (WGWD) – one of the two permanent WENRA working groups – has documented their results and published Safety Reference Levels (SRLs) in its respective reports on the decommissioning of nuclear facilities, the processing and storage of radioactive waste and on its disposal.

This document highlights the connections between the WGWD thematic reports by summarizing their content against the background of a comprehensive radioactive waste management programme. Interfaces and interdependencies between the reports – in particular those that are not covered by the SRLs – are considered, and guidance is offered by referring to internationally accepted requirements and recommendations, e.g. the Safety Standards of the International Atomic Energy Agency (IAEA).

The document was prepared by Bengt Hedberg with support from the chairman of the working group, Stefan Theis, and input provided by the members of WGWD.

1
Introduction

1.1 Background

The Western European Nuclear Regulators' Association (WENRA), composed of the heads of the nuclear safety regulatory authorities in Western Europe, was established in 1999. One of the main objectives of WENRA is to develop a common approach to nuclear safety, including the management of spent fuel and radioactive waste. To achieve these objectives two working groups have been established: the Reactor Harmonization Working Group (RHWG) and the Working Group on Waste and Decommissioning (WGWD).

The RHWG scope of work addresses the safe operation of nuclear power reactors, with the objective of ensuring the safety of the facility during the operational phase. The Safety Reference Levels (SRLs) developed by RHWG thus address detailed safety issues related to a specific type of facility, i.e. a reactor-facility-oriented approach. Due to the complexity of reactor operations and the associated risks, the RHWG SRLs have been developed to a greater level of detail than for the diverse facilities associated with the back-end of the nuclear fuel cycle.

The Working Group on Waste and Decommissioning (WGWD) of WENRA was founded in 2002 to develop a set of safety reference levels that would serve as references for the harmonization of national regulations dealing with all aspects of the back-end of the fuel cycle, similar to the task the RHWG was given with respect to reactor safety. WGWD has subsequently produced a total of four thematic reports, each report dealing with one specific aspect of radioactive waste management. These have been and are used to benchmark national regulatory systems. The methodology of these benchmarking exercises is described in detail in part III of any of the four WGWD reports.

Unlike the regulatory situation with respect to the operation of nuclear reactors – where there is a discreet facility usually operated by one license holder – the management of radioactive waste usually involves several license holders, locations and facilities at different steps of the waste management process. One of the main tasks of the regulatory body is therefore defined by the need to ensure clear and unequivocal responsibilities at every step of this process.

The radioactive waste management SRLs adopt a cradle-to-grave perspective, addressing radioactive waste from generation up to the final goal of disposal. Due to the step-wise and integrated character of waste management, some overarching responsibilities cannot be

expressed as SRLs addressing an individual licence holder. Such overarching aspects do not fall within the remit of WENRA and are thus outside the scope of the SRLs.

WENRA is mandated to develop Safety Reference Levels (SRLs) which apply to the licensee of a facility. It was recognised that not all of the relevant safety aspects of the management of radioactive waste could be included in the WGWD reports in the form of SRLs. The multi-faceted organisational and infrastructural challenges included in radioactive waste management are often expressed at the interfaces between different licensees. Therefore, the need to discuss these aspects – not in the form of SRLs or a regulatory benchmark, but to provide guidance to the WENRA member states about the limits of the WGWD's approach and how to overcome them – was agreed by the WGWD. Thus, this document was prepared to describe the interrelations between the different WGWD reports and put them into the context of a comprehensive radioactive waste management programme.

The SRL reports developed by WGWD are structured to address thematic activities applicable to a wide range of different types of facilities, regardless of the main purpose with the facility in question. Some of them primarily address facilities, like the disposal report other are primarily activity-oriented, like the processing report. The SRLs cover four thematic areas in individual reports:

- storage of radioactive waste and spent fuel,
- decommissioning of nuclear facilities,
- disposal of radioactive waste, and;
- processing (i.e. treatment and conditioning) of radioactive waste.

1.2 Scope and Objective

This document aims to fulfil three main objectives:

- to shed light on the interfaces and interdependencies that are only incompletely covered by the SRLs,
- to offer guidance on the role of the regulatory body in these instances
- to provide references to other organizations' bodies of work offering similar guidance, e.g. IAEA safety requirements and recommendations.

The requirements in the IAEA Safety Standards address member states and include requirements that go beyond the remit of the regulatory framework. For example, the IAEA Safety Standards address government responsibilities, responsibilities associated with the ownership of spent fuel and radioactive waste, as well as financing issues.

WENRA directors have agreed to develop harmonized SRLs based on good practice in WENRA member states and the IAEA Safety Standards. WENRA directors have also committed to the continuous improvement of national regulatory systems, using the WENRA SRLs as a minimum.

WENRA SRLs are applicable to nuclear activities requiring a nuclear license and are therefore aimed at licensees. Consequently, pre-licensing activities are not covered by the SRLs, and interactions and interdependencies between the different organizations involved in radioactive waste management cannot be imposed as joint or shared responsibilities.

This document does not contain any SRLs to be implemented by WENRA member states in the national regulatory framework. Instead, this document provides a high-level contextual overview of the SRL reports developed by the WGWD in relation to the overall national context for the management of radioactive waste as well as decommissioning of nuclear facilities.

1.3 Structure

Chapter 2 of this document identifies those aspects of a comprehensive radioactive waste management programme that are not within the scope of the WGWD's main reports and describes, at a general level, the regulatory body's role and the interfaces between license holders.

Chapter 3 of this document contains an overview of the different WGWD thematic reports and identifies the main safety relevant interfaces between each topic, from the generation of radioactive waste to its disposal.

2
General Considerations

-

2.1 Overarching Responsibilities

The basic principles that *the prime responsibility for ensuring the safety of nuclear activities rests with the holder of the license* (often, but not always the owner of the facility), as well as *that the ultimate responsibility rests with the state,* are fundamental prerequisites for establishing a comprehensive waste management programme at the national level. The principles are acknowledged in the Convention on Nuclear Safety[1] and in the Joint Convention[2] as well as in the Nuclear Safety Directive[3] and the Waste Directive[4].

These fundamental principles, governing roles and responsibilities at the national level should be implemented in the legal and regulatory framework in all WENRA member states. The methods of implementing the principles rests within the competence of the WENRA member states and thus across them ways of implementation differ. Several different models exist with the waste owner and facility license holders being either private commercial entities or state organizations, and as a result responsibilities for decision making can differ. This notwithstanding, the national government exercises ultimate responsibility by granting – or withholding – approval to the management solutions proposed by the operator or license holder in question.

It follows from the preconditions described above that the formal responsibility for nuclear activities, subject to a nuclear license, is defined by such license according to national legislation. WENRA-SRLs can only be applied to the license holders within the context of such license and the means of implementation of the corresponding regulatory system. .

---

[1] The Convention on Nuclear Safety, INFCIRC/449, 5 July 1994

[2] The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, INFCIRC/546, 24 December 1997

[3] EC Directive 2009/71/2009, 25 June 2009, as amended by EC Directive 2014/87/Euratom, 8 July 2014

[4] EC Directive 2011/70/2011, 19 July 2011

2.2 License Holder Responsibilities

Due to WENRA's mandate, the WGWD has largely aimed the SRLs at the license holder. In some cases, in particular those associated with the processing or disposal of radioactive waste the WGWD has tried to reflect the importance of certain issues by developing requirements that would affect several interacting organizations, all of them holders of separate licenses.

Generally, the waste owner (often, but not always the waste generator) is assigned overall responsibility in the national legislation for the safe and responsible management and disposal of waste generated during operation within the context of the license. However, one or more steps in the waste management process may be contracted out to other organizational entities holding a license to perform specific steps in the overall process. Therefore, while the waste owner holds the overall responsibility for the management of the wastes, the safety and outcome of these outsourced activities no longer fall within his direct responsibility.

The specific challenge in this context thus relates to the interface of the more general responsibilities on the waste owner and the responsibility of license holders acting as service providers and who are responsible for specific activities as part of the overall cradle-to-grave process. It is the responsibility of the regulatory body to develop requirements on individual license holders and to ensure that all license holders comply with regulatory requirements – thereby ensuring that each step in the process contributes to the overall system of safe management of radioactive waste.

2.3 Single-Case Countries

Typically the WGWD benchmarks national regulations against the requirements defined by the SRLs in the thematic WGWD reports. Some countries have chosen their overall radioactive waste management strategy so as to concentrate certain waste management activities and responsibilities on a single license holder. In cases like this – as long as there is very clear and unequivocal allocation of responsibilities – it is equally acceptable to refer to requirements of this singular license to prove compliance with the WGWD safety requirements rather than referring to generally applicable parts of the national regulatory system.

2.4 Funding

Although funding is an important element of ensuring safe decommissioning of nuclear facilities and the safe and responsible management of spent fuel and radioactive waste, this does not fall within the scope of WGWD reports. This is not least because arrangements for assessing costs and ensuring proper funding mechanisms are in most countries subject to

requirements formalised in specific legislation for which member organi1ations of WENRA are not responsible.

The need to ensure the continuity of responsibilities and the fulfilment of funding requirements is acknowledged by the IAEA as being part of the fundamental safety principles guiding all licensed activities which generate radioactive waste[5]. Accordingly, the securing of financial and other resources is clearly defined as being part of the government responsibilities within the framework for predisposal waste management[6], decommissioning[7] as well as disposal[8].

2.5 Other Licensing Regimes

The WGWD-reports address relevant nuclear and radiological safety requirements, but do not take into account other regulatory regimes governing requirements such as:

- environmental impact assessment regulation (required by EU directives),
- discharge authorization,
- clearance,
- exemption,
- chemical toxicity of disposed radioactive waste ,
- management of non-radioactive waste,
- conventional occupational health and safety,
- physical protection including safeguards, and;
- funding.

Although outside the scope of SRLs, these issues are especially relevant to waste treatment and conditioning facilities as well as to the decommissioning of nuclear facilities, and should be addressed in accordance with the applicable national regulatory requirements.

[5] IAEA: SF-1, Principle 1 and also para 3.7

[6] IAEA: GSR Part 5, Requirement 1

[7] IAEA: GSR Part 6, Requirement 4

[8] IAEA: SSR-5, Requirement 1

2.6 NORM and Post-Accident Waste Management

Materials containing radionuclides of natural origin (NORM), e.g. mining and mineral processing waste as referred to in IAEA SSR-5, are not within the scope of WENRA and as such are not addressed in the WGWD reports. While some NORM waste may be processed in facilities covered by the SRLs in the WGWD reports, any specific aspects relating to such waste such as large volumes, physical state, etc. have not been considered when drafting the SRLs. Various ways of managing such waste are implemented in different countries, depending on the characteristics and level of activity of the waste. Some NORM waste may be managed in radioactive waste disposal facilities due to their level of activity, for example as low-level radioactive waste. Other types of waste may be managed either in landfills or even directly on the sites where they were produced, when specific activity is low and there are large amounts of waste.

The same considerations apply for the management of radioactive waste generated as a result of accidents or unforeseen events. Reactor accidents, especially if large amounts of radioactive material are released into the environment, may cause the contamination of large volumes of soils and waters. The efforts in remediation and clean-up may be extensive and the amount of material which has to be disposed as radioactive waste may be equally significant. While this waste does not fall under the mandate of the WGWD, its processing, storage and eventual disposal may be informed by the same considerations that underlie the thematic WGWD reports.

3
Interfaces and Interdependencies between the WGWD Reports

-

The management of radioactive waste is a multi-step process, and virtually every radioactive waste will have to undergo several of these steps before it is finally disposed of. Even before the generation of the waste, the successful implementation of a comprehensive waste management strategy may comprise early efforts of waste minimization and defining what kind of waste will be generated at all. By issuing or withholding respective licenses, it is the responsibility of the regulatory body to either ensure the compatibility of the waste with the overall strategy or to require the responsible organization to adjust the overall strategy to the specific waste type.

Because radioactive waste will pass through several stages of waste management – from collection to storage and further on to disposal, with each of these steps possibly accompanied by steps of waste processing and transport to a dedicated site or facility – it may also pass through the hands of more than one license holder. Each license holder may be tasked with a clearly defined objective, e.g. the storage of waste or the production of a waste package that can safely be stored over an extended period of time. It is the responsibility of the regulatory body to ensure that considerations necessary for the successful implementation of the comprehensive waste management strategy are accounted for, both between the different waste management steps and between the waste owner and any other license holders who may take responsibilities for some of those steps.

This chapter therefore documents some of the overarching aspects that require consideration. Special attention will be given to interface issues that could only partly be addressed by the SRLs set in the thematic WGWD reports for the reasons described above. The first part of the chapter discusses general considerations applying to the whole process of radioactive waste management. The latter part of the chapter summarizes the contents of the WGWD reports and highlights the interfaces between the WGWD reports.

3.1 Overall Considerations

Knowledge Management

One of the most important non-physical aspects of radioactive waste management is the management of knowledge and information. To ensure the safe handling and disposal of radioactive waste, any safety relevant properties of the radioactive waste must be understood at every step of the process. While the characterization of radioactive waste is an important step once radioactive waste has been packaged physical access to the waste form is usually quite limited and additional measurements to determine the properties of the radioactive waste later will surely come with considerable efforts in time, costs and additional worker doses. Therefore, comprehensive documentation of properties and management steps of the radioactive waste and the continuing preservation of such is of elementary importance, and these aspects are covered in all reports published by the WGWD.

Similarly, aspects of knowledge management are prominent in the publications of the IAEA. The use of well-managed good quality information is seen as key to dealing with interdependencies in radioactive waste management (see GSR Part 5, Requirement 6 and para 3.22). Part of this is the continuous characterization and classification of radioactive waste to '*provide information relevant to the process control and assurance that the waste or waste package will meet the acceptance criteria for processing, storage, transport and disposal of the waste*' (GSR Part 5, para 4.11; see also Requirement 9, ibid.). Record keeping is crucial to retain this information (see thematic WGWD reports and references therein).

Similarly, knowledge about a repository and its contents will also have to be preserved, even after the closure of the site, and will have to be made accessible to future generations in a way that they will be able to understand. This specific aspect of knowledge management is addressed in section 3.4 of the Disposal Report (see below).

Clearance

The WGWD is only mandated to deal with materials designated as radioactive waste. Therefore, the handling and management of materials that may be designated as waste at a later date is not covered by the mandate. Internationally, radioactive waste is usually defined as material that contains or is contaminated with radionuclides at activity concentrations greater than clearance levels and for which no further use is foreseen[9, 10, 11, 12].

[9] IAEA: Safety Glossary

[10] EU: Council Directive 2011/70/Euratom, Article 3 (7)

[11] EU: Council Directive 2013/59/Euratom

[12] IAEA: RS-G-1.7 *Application of the Concepts of Exclusion, Exemption and Clearance*.

The aspect of clearance of material is not only crucial to the generation and pre-treatment of radioactive material, i.e. collecting and segregating material that qualifies as radioactive waste or decontaminating large volumes of waste in the decommissioning of nuclear facilities. For example, radioactive material can be stored over an extended period of time with the aim to reducing the amount of material that will later have to be dealt with as radioactive waste (decay storage). The IAEA defines this as a viable strategy in GSR Part 5, para 4.1.

Furthermore, processing of waste, in particular in the extraction and concentration of radionuclides, certain waste streams may be produced that no longer will qualify as radioactive waste and which can be disposed of in a conventional manner. A detailed treatment is found references 10-12.

Transport

Transport of radioactive waste is an everyday necessity. The technical challenges associated with this are specific to the properties of the waste that is to be transported, and thus will differ greatly, for example in the transport of large amounts of low-active waste compared to small volumes of spent fuel or other high-active radioactive waste. Accordingly, dedicated treatment and conditioning steps may be necessary to ensure safe transport. The responsibility to declare a waste package fit to be transported usually rests with the license holder in direct control of the waste.

The WGWD has largely refrained from discussing transport issues. However, ensuring the suitability of waste packages intended for transport is reflected in several of the reports, most prominently the SRLs provided in the Processing Report. Ensuring the safe transportability of the packages stored is also reflected in storage SRLs (see S-51).

The IAEA offers further guidance on how to ensure and how to account for transportability in the process of decommissioning and dismantling of nuclear facilities in a general [13, 14, 15], as well as in a more detailed[16, 17, 18] manner.

[13] IAEA: GSR Part 5

[14] IAEA: GSR Part 6

[15] IAEA: WS-G-2.1

[16] IAEA: GS-R-1

[17] IAEA: TS-R-1

[18] IAEA: TS-G-1.1

Secondary Waste Generation

All handling of radioactive material will inevitably produce some secondary waste, if only by means of contamination and activation. Management of secondary waste therefore applies to all activities discussed in the thematic WGWD reports. This secondary radioactive waste has to be accounted for and managed appropriately, while in order to apply the waste hierarchy minimization of secondary waste generation should inform all activities.

SRLs to this effect have been formulated in the Processing Report (P-29 and P-45), where they are most relevant, but secondary waste generation should be considered during the whole process of managing radioactive waste. For further guidance, refer to the IAEA's GSR Part 5, WS-G-2.5 and WS-G-2.6.

3.2 Report on Waste and Spent Fuel Storage Safety Reference Levels

The report primarily addresses purpose-built or adapted storage facilities used to store spent fuel or radioactive waste in solid form. This also applies to dedicated storage facilities operated within or in combination with other nuclear facilities. Not covered are spent-fuel pools built for the operation of reactors.

The storage SRLs apply to a wide range of facilities for the storage of spent fuel and radioactive waste, for which the hazard potential may vary significantly. As a result, the SRLs should be implemented in different ways –*in a graded approach*-, appropriate to the particular facility. Consideration should also be given as to whether individual SRLs are relevant in specific circumstances, and to situations where they can be applied in a proportionate manner, taking into account the magnitude of the hazard.

With regard to interfaces, the Storage Report acknowledges the need for the facility license holder to develop criteria to determine whether the incoming waste is suitable for storage in the facility, and to manage any wastes that are found to be unsuitable.

The design storage period involved is typically several decades, depending on the national waste and spent fuel management strategy.

Extended Periods of Storage

While the expected period of storage that forms the design basis for the storage facilities is usually already in the range of several decades, delays in the construction and operation of waste disposal facilities may mean that radioactive waste has to be stored for a period of time that goes beyond the expected storage duration or even the projected lifetime of the storage facility. In these cases, there have to be means to ensure the continued safe storage of the radioactive waste. This is reflected in the Storage Report by an emphasis on the need for regular inspections of the stored waste and of the facility itself (see Safety issue *Maintenance, periodic testing and inspection*). This also informs those SRLs dealing with provisions for the any

degradation effects, for ensuring the suitability of the waste packages for transport and for the requirements for subsequent disposal and other waste management options.

3.3 Report on Decommissioning Safety Reference Levels

The Decommissioning Report provides harmonized SRLs applicable during design, construction, operation, and decommissioning of a nuclear facility to ensure a safe decommissioning process. They cover a wide range of sites and facilities (from small isolated nuclear facilities to large complex reprocessing or reactor sites), and need to be implemented in a manner appropriate to the particular facility, taking into account the magnitude of the hazard in a graded approach. The decommissioning strategies and plans necessary to ensure safety need to be commensurate with the type and status of the facility and the hazards associated with the decommissioning of the facility. The decommissioning SRLs are not intended to be applicable to uranium mining and milling, or to isotope production facilities other than reactors.

The decommissioning SRLs mainly address the radiological hazards resulting from the activities associated with the decommissioning of facilities, primarily with decommissioning after a planned shutdown. Non-radiological hazards can also arise during decommissioning activities. These hazards should also be given due consideration during the planning process and in the risk analyses as far as they may influence the radiological hazards or risks.

The point at which decommissioning starts will vary from country to country depending on national arrangements, ranging from the decision to shut down the facility up to the beginning of dismantling activities. For the purposes of the decommissioning SRLs, it is assumed that the normal operational phase includes the removal of the bulk of spent fuel and radioactive materials from the facility in accordance with the safety case for normal operations. In certain cases part of the nuclear inventory of a facility is only removed after the start of decommissioning activities. In such cases, appropriate SRLs (e.g. for criticality control) for the operational phase of the facility remain applicable. The decommissioning phase is technically assumed to start once further operations cannot be carried out using normal operational methods or within the bounds of the safety case for normal operation. The decommissioning phase is usually governed by a specific decommissioning license or authorization.

Decommissioning as Part of Facility Planning

Waste minimization and the safe dismantling of nuclear facilities are key aspects of the successful implementation of a comprehensive radioactive waste management strategy. In this regard, the Decommissioning Report recognizes the interdependency with the design and construction of a facility and addresses them in the Safety area *Decommissioning strategy and planning*.

Waste Management Starts at Decommissioning

The dismantling of nuclear facilities is usually associated with the generation of large volumes of radioactive waste which will have to be taken care of within a comprehensive radioactive waste management programme. The Decommissioning Report stresses the importance of initiating waste management at the outset, with requirements to characterize, segregate and manage radioactive waste from its generation, to optimize the respective arrangements and to ensure the keeping of the relevant documentation and records (see Safety issue *Waste management*).

Due to the need to process radioactive material for further storage and transportability, waste treatment and conditioning activities are usually part of any dismantling operation and as such covered under the decommissioning license. The Decommissioning Report addresses also the use of new installations or equipment introduced into the facility in the frame of the decommissioning project in its Safety Issues *Control of decommissioning activities* and *Contents, review and update of the safety case for decommissioning*. The waste processing activities themselves are covered by the corresponding SRLs in the Processing Report.

3.4 Report on Radioactive Waste Disposal Safety Reference Levels

The Disposal Report provides harmonized SRLs applicable to activities and facilities related to the disposal of radioactive waste which, due to its specific content of radionuclides, requires arrangements to protect human health and the environment against dangers arising from ionizing radiation as the end point of its management.

The SRLs are focused on near-surface, intermediate-depth or deep geological facilities for disposal of radioactive waste in solid form. In the case of geological disposal, this can include spent fuel if designated for direct disposal. Although the safety objective is the same whatever the type of disposal facility, the means for reaching it may differ considerably depending on the type of waste to be disposed of. The SRLs apply to a wide range of disposal facilities and thus have to be applied in a proportionate manner, taking account of the magnitude of the potential hazard of the waste to be disposed of. This graded approach should also be applied to specific facilities, so that the provisions made and means of implementation within the facility are proportionate to the hazards identified.

Although in some countries disposal facilities for very low-level waste are not regulated under the regulations for nuclear facilities, it is recommended that the disposal SRLs are taken into consideration in a suitably proportionate manner for these facilities.

Post-Closure Safety

Radioactive waste disposal facilities present a unique challenge due to the need to demonstrate safety over long periods after closure. Depending on the radiological hazard presented by the waste and the type of facility, these periods may span a few hundred years (for short-lived waste) to several hundred thousand years or more (for long-lived waste). Providing post closure safety over long time periods is addressed in many SRLs throughout the disposal report but specifically in the safety issues 2.2.7 and 2.4.8.

Simultaneous Construction, Operation and Closure

Starting with the first emplacement of waste, near surface as well as deep geological repositories receive waste while other sections are still under construction. In advanced stages of operation earlier filled sections will already be closed. This special situation is not only a challenge to the operators but also to the regulators. In any case it provides a wide range of interface issues which are uncommon to other types of nuclear facilities.

3.5 Report on Radioactive Waste Treatment and Conditioning Safety Reference Levels

The radioactive waste treatment and conditioning SRLs have to reflect the variety of scenarios in which radioactive waste is processed, i.e. at the site of generation (potentially using mobile equipment) or in a dedicated waste processing facility; the inherent hazards (radiological and non-radiological) associated with the waste; and the actual purpose of the processing steps in question. Due to the wide range of waste types and activities, a graded approach with respect to the requirements defined in the Processing Report is necessary.

While there are dedicated facilities for the processing of radioactive waste, the first steps of waste treatment or conditioning will often take place where the radioactive waste is generated or accumulates, e.g. as the result of the operation or decommissioning of a nuclear facility. Such a facility or equipment used is usually operated under the original license of the facility operator or decommissioning license holder. Clear allocation of responsibilities, as always, is crucial in such arrangements. The respective waste processing activities fall under the scope of the Processing Report and are covered by the SRLs applicable to the situation.

While the SRLs in the Processing Report apply to all steps of radioactive waste treatment and conditioning, it was decided not to include requirements for the regulation of pre-treatment steps. Pre-treatment may describe activities carried out on material that is not yet declared radioactive waste and thus falls outside the scope of the WGWD. The IAEA deals with pre-treatment in its predisposal waste management safety requirement and safety guides, i.e. GSR Part 5 and WS-G-2.5 and WS-G-2.6, respectively.

The SRLs also cover all types of radioactive waste from low-level solid waste to slurries and reprocessing waste, including the processing of spent fuel designated for disposal. It does not, however, cover the reprocessing of spent fuel as the spent fuel assigned for reprocessing is not designated as radioactive waste.

As radioactive waste treatment and conditioning is intimately associated with the interfaces to the prior and subsequent steps of radioactive waste management, interface issues are already at the heart of the Processing Report and are reflected in many SRLs, in particular those dealing with the chosen process and the products (see Safety area *Process and product requirements*) and the establishment of a Quality Assurance programme (see Safety issue *Product quality*).

Appendix
References

–

The following documents were used as references in the compilation of this report, even if some of them are not directly referenced or do not appear as footnotes. They may serve as starting points for further guidance and details:

- WENRA – Waste and Spent Fuel Storage Safety Reference Levels Report, version 2.2 (2014)
- WENRA – Decommissioning Safety Reference Levels Report, version 2.2 (2015)
- WENRA – Disposal Facilities Safety Reference Levels Report, version 1.0 (2014)
- WENRA – Radioactive Waste Treatment and Conditioning Safety Reference Levels Report, version 1.0 (2016, to be published)
- Fundamental Safety Principles, IAEA Safety Fundamentals SF-1, Vienna (2006).
- Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, IAEA Requirements, GS-R-1, Vienna (2000)
- Regulations for the Safe Transport of Radioactive Material, IAEA Requirements, 1996 Edition (Revised), TS-R-1 (ST-1, Revised), Vienna (2000)
- Predisposal Management of Radioactive Waste, IAEA General Safety Requirements, GSR Part 5, Vienna (2009).
- Decommissioning of Facilities, IAEA General Safety Requirements, GSR Part 6, Vienna (2014)
- Disposal of Radioactive Waste, IAEA Specific Safety Requirement, SSR-5, Vienna (2011)
- Decommissioning of Nuclear Power Plants and Research Reactors, IAEA Safety Guide, WS-G-2.1, Vienna (1999).
- Predisposal Management of Low and Intermediate Level Radioactive Waste, IAEA Safety Guide, WS-G-2.5, Vienna (2003).
- Predisposal Management of High Level Radioactive Waste, IAEA Safety Guide, WS-G-2.6, Vienna (2003).
- Application of the Concepts of Exclusion, Exemption and Clearance, IAEA Safety Guide, RS-G-1.7, Vienna (2004)
- Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material, TS-G-1.1, Vienna (2002)
- Convention on Nuclear Safety. INFCIRC/449. 5 July 1994

- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. INFCIRC/546. 24 December 1997.

- Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations
- Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste
- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation
- Council Directive 2014/87/Euratom of 8 July 2914 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations