IAEA TECDOC SERIES

IAEA-TECDOC-1816

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Model Regulations for Decommissioning of Facilities

IAEA
International Atomic Energy Agency

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MODEL REGULATIONS FOR DECOMMISSIONING OF FACILITIES

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INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2017

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FOREWORD

When a facility is to be decommissioned, consideration has to be given to ensuring protection and safety both during the decommissioning process itself (including the management of the associated radioactive waste) and following the release of the site from regulatory control. To ensure an acceptable level of protection and safety is maintained, States need to adopt an appropriate management and regulatory approach and to implement relevant standards.

Many States are currently faced with the decommissioning of ageing facilities that are nearing the end of their life or of facilities that have already been permanently shut down. In some cases, an adequate legal and regulatory framework for protection and safety is not yet in place. In other cases, a legal and regulatory framework is in place but is oriented towards operational activities, with decommissioning activities only starting to be considered or not considered at all. This publication provides information on an appropriate set of regulations covering all aspects of decommissioning

The IAEA has systematic programmes to provide Member States with the guidance, services and training necessary for establishing a legal and regulatory framework, including the planning and implementation of decommissioning. The IAEA has already published various safety standards relevant to the decommissioning of facilities and the management of the associated radioactive waste. The development of the model regulations for decommissioning in this publication is a logical continuation of these efforts. The set of regulations in this publication is based on the requirements established in the IAEA Safety Standards Series, in particular GSR Part 6, Decommissioning of Facilities. The model regulations fill a gap that was identified in several IAEA expert missions and by the organizers of IAEA groups for the drafting of regulations on radiation safety.

These model regulations cover all aspects of the planning, conduct and termination of the decommissioning of facilities and management of the associated waste. They are in accordance with the relevant requirements of the IAEA safety standards. They provide a framework for establishing regulatory requirements and conditions of authorization to be incorporated into individual authorizations for the decommissioning of specific facilities. The model regulations also establish criteria to be used for assessing compliance with regulatory requirements.

This publication will be of assistance to States in appraising the adequacy of their existing regulations and regulatory guides, and serves as a reference for those States developing regulations for the first time. For the benefit of States whose legal and regulatory framework does not explicitly address decommissioning, this publication also gives a brief explanation of the process for establishing the necessary legal and regulatory framework and of the regulatory process applicable to decommissioning.

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1. INTRODUCTION

1.1. BACKGROUND

The fundamental safety objective of protecting people and the environment has to be achieved without unduly limiting the operations of facilities or the conduct of activities that give rise to radiation risks .The IAEA publication Fundamental Safety Principles (IAEA Safety Standards Series No. SF-1) [1] sets out the various safety principles that provide the basis for the IAEA safety standards. With respect to the role of government, one of the principles states: "An effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained". The IAEA publication Governmental, Legal and Regulatory Framework for Safety, (IAEA Safety Standards Series No. GSR Part 1) [2] sets out the general requirements that have to be met in this regard. The regulatory body established in accordance with these requirements has to be appropriately organized and staffed, have well defined responsibilities and functions, and have access to adequate resources. The availability of supporting expertise and technical services has to be ensured and a strong commitment to safety by the government and all other bodies responsible for safety is essential.

The achievement and maintenance of a high level of safety in the decommissioning of facilities and in the management of the associated radioactive waste depends on the adoption of appropriate regulatory standards. Part 3 of the General Safety Requirements (IAEA Safety Standards Series No. GSR Part 3: Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards) [3] sets out the basic safety standards to be incorporated into the regulatory framework. Part 6 of the General Safety Requirements (IAEA Safety Standards Series No. GSR Part 6: Decommissioning of Facilities) [4] establishes the general safety requirements that have to be met for all aspects of the planning, conduct and termination of the decommissioning process. The way in which States apply these requirements will vary depending on factors such as the nature of the legal system, technical resources and the scale of the facilities that are to be decommissioned. Although national circumstances will determine whether or not safety is addressed in separate legislation, specific provision for decommissioning safety always needs to be included.

Guidance relevant to decommissioning has been established in IAEA Safety Standards Series No. WS-G-5.1: Release of Sites from Regulatory Control on Termination of Practices [5] and IAEA Safety Standards Series No. WS-G-5.2: Safety Assessment for the Decommissioning of Facilities Using Radioactive Material [6]. IAEA Safety Guides on the decommissioning of nuclear power plants and research reactors [7], of medical, industrial and research facilities [8], and of nuclear fuel cycle facilities [9] are currently being updated.

The decommissioning of facilities usually results in the generation of radioactive waste. The objective of safe management of radioactive waste is to protect individuals, society and the environment, now and in the future, without imposing undue burdens on future generations. This is achieved by adopting radioactive waste management practices that will ensure compliance with international safety standards on protection and safety and radioactive waste management. Requirements for the management of radioactive waste are set out in IAEA Safety Standards Series No. GSR Part 5: Predisposal Management of Radioactive Waste [10] and IAEA Safety Standards Series No. SSR-5: Disposal of Radioactive Waste [11]. In addition, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste (the Joint Convention) [12] has introduced a comprehensive set of obligations for which provision has to be made in the national legislation of those States that have ratified this convention.

1.2. OBJECTIVE

The objective of this TECDOC is to assist technical and legal experts in the development of new regulations on all aspects of the decommissioning of facilities and in the assessment of the adequacy of existing regulations and regulatory guides on decommissioning. The model regulations set out in this TECDOC will need to be adapted to take account of local conditions, technical resources and the scale of facilities and activities in the State concerned. Many of these model regulations may also be used for decommissioning after an abnormal event that has resulted in serious plant damage or facility contamination. In this case, these model regulations may be used as a basis for developing special decommissioning provisions once the facility has been brought to a safe configuration. Guidance provided here, describing good practices, represents expert opinion but does not constitute recommendations made on the basis of a consensus of Member States.

1.3. SCOPE

This TECDOC contains advisory material related to matters that need to be addressed in policies, strategies, and regulations of a State, in relation to the decommissioning of facilities. It addresses all regulatory aspects of the decommissioning of facilities and the management of the associated radioactive waste, taking into account the principle of the graded approach to regulation [3]. The scope of this TECDOC is such as to be applicable to the broad range of regulatory systems in existence and to all types of facilities at all stages of their lifetime (including facilities that are no longer in operation but have yet to be decommissioned). Examples of such facilities are:

- Nuclear power plants, research reactors and other nuclear installations;
- Facilities involving NORM, including the mining and processing of radioactive ore;
- Medical, industrial and research facilities in which radioactive materials and sources are produced, received, used and stored;
- Facilities for predisposal management of radioactive waste such as treatment, conditioning and storage facilities;
- Other supporting facilities associated with radioactive waste management.

The model regulations set out in this TECDOC are not applicable to radioactive waste disposal facilities, including engineered NORM waste containments, since these are subject to the process of closure rather than decommissioning.

Non-radiological hazards, such as those due to potential fire sources or those resulting from the handling of material containing asbestos, can also arise during decommissioning actions. This TECDOC does not explicitly address these hazards, but it is important that they be given due consideration during the planning process and in any safety assessment.

1.4. STRUCTURE

The main focus of this TECDOC is to provide model regulations for decommissioning based on the requirements and guidance set out in the IAEA safety standards, but this is preceded by an overview of the process for establishing the necessary legal and regulatory framework and the regulatory process as it applies to decommissioning.

Following this introductory section, Section 2 of this TECDOC examines the various aspects of the legal framework for decommissioning. Section 3 provides advice for drafting or revising the law. Section 4 outlines issues to be considered in the regulatory process. Section 5 outlines issues to be considered in the development of regulations. Section 6 summarizes the

functions of the regulatory body. Finally, Section 7 sets out the model regulations for decommissioning. Additional information is provided in three appendices. Appendix I gives an example of a table of contents of a decommissioning plan, Appendix II gives an example of a format for a final decommissioning report, while Appendix III gives an example of a format for a site remediation plan.

2. LEGAL FRAMEWORK FOR DECOMMISSIONING

2.1. GENERAL CONSIDERATIONS

States need to develop national policies and implementation strategies for safety and radioactive waste management with respect to all types of facilities and activities, including those associated with decommissioning. In terms of these policies and strategies, States need to establish a legal framework that provides for the regulation of the relevant facilities and activities. The number and types of facilities to be decommissioned in a State, together with the types of decommissioning activities planned for the future, will influence the content of the legislation, as well as the extent of the regulatory infrastructure that is needed to ensure safety. The legal framework has to ensure that a regulatory body is established, and has the necessary authority and independence from organizations in charge of the utilization and promotion of technologies involving exposure to radiation.

The relevant requirements arising from the articles of the Joint Convention [12] and the requirements embodied in IAEA Safety Standards Series No. GSR Part 1: Governmental, Legal and Regulatory Framework for Safety [2] provide the basis for establishing or amending the legal framework.

The legal framework will need to cover in a comprehensive and integrated manner all aspects of safety, radiation protection, safeguards, physical protection, security, financing and nuclear liability related to the decommissioning of facilities. Further guidance on the legal framework and on suitably comprehensive legislation for regulating facilities and activities involving radioactive material can be found in the Handbooks on Nuclear Law [13, 14]. Guidance relating to the independence of the regulatory body can be found in Ref. [15].

2.2. NATIONAL LEGAL HIERARCHY

The legal framework for the regulatory control of decommissioning is part of a State's general legal system. . In spite of all variants that can be found from one country to another, the most common hierarchy starts with the State's Constitution. A distinction is commonly made between primary legislation represented by the law itself and regulations that are often technical in nature. Finally, many national legal systems recognize regulatory guides that specify performance expectations in fulfilling the requirements established by the legislation and regulations. More details on the national legal hierarchy are given in the Handbooks on Nuclear Law [13, 14]

2.3. NATIONAL POLICIES AND STRATEGIES

It is important for national policies for safety and for the management of radioactive waste and spent fuel to address all aspects of the decommissioning of facilities, including the assignment of responsibilities for decommissioning and for the management of the associated radioactive waste and spent fuel. Consideration needs to be given to the expected end states for decommissioning, including the management of the radioactive waste produced during the decommissioning period, and the time frames involved.

In general, national policies reflect national priorities and circumstances, while being compatible with international instruments such as any conventions and codes recognized by the State. In particular, the Joint Convention [12] and other international instruments such as safeguards agreements and the Convention on Physical Protection of Nuclear Material and its Amendment [16] have to be considered. Other publications relevant to the development of national policies for safety and for the management of radioactive waste and spent fuel are IAEA Safety Standards Series Nos GSR Part 1 [2] and GSR Part 3 [3], and IAEA Nuclear Energy Series No. NW-G-1.1 [17].

A national policy for safety would be expected to incorporate the fundamental safety principles internationally recognized. These include the top priority assigned to safety, a long term commitment to safety, the importance of protection of human health and society, the importance of protection of the environment, and the involvement of interested parties in decisions on protection and safety.

The IAEA Fundamental Safety Principles [1] provide the basis for the development of a national policy on the management of radioactive waste and spent fuel. In particular, Principle 7 of the Fundamental Safety Principles states:

> "People and the environment, present and future must be protected against radiation risks.
>
> ……..
>
> "3.29. Radioactive waste must be managed in such a way as to avoid imposing an undue burden on future generations; that is, the generations that produce the waste have to seek and apply safe, practicable and environmentally acceptable solutions for its long term management".

Depending on national circumstances, a State may choose to develop a specific national policy on decommissioning. Irrespective of the formal approach used, the following elements are examples of what would generally be considered in the national policy:

- The various decommissioning strategies, including funding, that may be implemented by the registrant or licensee;
- The final status of the facility following decommissioning and termination of the authorization;
- Communication with members of the public.

Further details are given in Ref. [18].

2.4. STRATEGIES FOR DECOMMISSIONING

The distinction between a national policy and a national strategy is not always obvious. A national strategy describes the various arrangements to be put in place to ensure proper implementation of a national policy and to make sure that the interaction between different steps and involved parties are adequately considered. A comprehensive set of arrangements (set out for instance in the State's legal framework) is generally put in place to ensure the safety of decommissioning and of the management of the associated radioactive waste. In this regard, it will be important to specify in the national strategy the structure of the regulatory body and the control exercised by it.

Whereas the national strategy on the management of radioactive waste and spent fuel may indicate the preferred decommissioning strategies that the State intends to follow, the implementing strategy of the registrant or licensee will specify the necessary coordinated actions for putting the national strategy into practice. Strategies for decommissioning that have been chosen by the registrant or licensee may include either immediate dismantling or deferred dismantling [18]. In principle, these two possible decommissioning strategies are applicable to all facilities.

(a) *Immediate dismantling*: In this case, decommissioning actions begin shortly after permanent shutdown of the facility. Equipment and structures, systems and components of a facility containing radioactive material are removed and/or decontaminated to a level that permits the facility to be released from regulatory control for unrestricted use, or released with restrictions on future use.
(b) *Deferred dismantling*: In this case, after removal of the nuclear material from the facility (in the case of nuclear installations), radioactive material in all or part of the facility is either processed or placed in such a condition that it can be put into safe storage and the facility maintained until it is subsequently decontaminated and/or dismantled. Deferred dismantling may involve early dismantling of some parts of the facility and early processing of some radioactive material and its removal from the facility, as preparatory steps for safe storage of the remaining parts of the facility.

A combination of these two strategies may be turn out to be the most practicable approach on the basis of safety requirements or environmental requirements, technical considerations and local conditions such as the intended future use of the site, or financial considerations. Entombment, in which all or part of the facility is encased in a structurally long lived material, is not considered a decommissioning strategy and is not an option in the case of planned permanent shutdown. It may be considered a solution only under exceptional circumstances (e.g. following a severe accident).

In the case of a multi-facility site, the development of an overarching site strategy might be appropriate. This site strategy would consider current and possible future shared resources, possible common infrastructure, and economies of scale that may result from combining decommissioning projects.

3. THE LAW

3.1. LEGAL BASIS FOR DECOMMISSIONING

The law enacted by the highest law making body of the country (the national legislature or parliament) provides the legal basis for decommissioning, for the safe management of the associated radioactive waste, and for an appropriate level of regulatory control. Guidance and model provisions for drafting or revising the law are given in Refs [13, 14].

3.2. BASIC REQUIREMENTS

The regulatory system adopted in a particular State would have to conform to the legal practice of that State, but the objective is the same, whatever the system. Basic requirements and obligations would be decided upon by the legislature. While any changes to these basic requirements and obligations would require the attention of the legislature, it can be expected that the implications of any such changes would be of sufficient importance to warrant such attention. The details of how the basic requirements would be implemented could be provided in regulations and guidance documents, allowing them to be changed more readily.

It is important that gaps and overlaps in the regulatory infrastructure for decommissioning safety and for the safety of the associated radioactive waste are avoided, and that cooperation between government agencies is facilitated. In this regard, it is important to ensure that the legislation covers all aspects of protection and safety and clearly allocates responsibilities among the government agencies involved. Two actions can be taken to achieve these objectives. The first action is to examine the existing legislation of relevance in order to understand how the government bodies that are currently involved might be affected and the extent to which the decommissioning activities might already be covered by existing legislation. The second action is to involve all the interested parties (including the relevant authorities) in the development of new legislation to ensure consistency and avoid gaps and overlaps. This latter action is typically accomplished by forming an interagency drafting committee having appropriate technical and legal competence.

The national approach to coordination and cooperation between governmental bodies in implementing a strategy on decommissioning and the management of the associated radioactive waste will depend on the national legal framework. It is critical that cross-cutting relationships be taken into account and, specifically, that a strategy for decommissioning be properly related to the national strategy for the management of radioactive waste and spent fuel. In summary, the establishment of an appropriate legal framework and regulatory infrastructure needs to include:

(a) Governmental commitment to protection and safety with regard to decommissioning and waste safety; this is a prerequisite for achieving the desired objective;
(b) Establishment of a regulatory body through the promulgation of appropriate legislation;
(c) Development of regulations and supplementary guidance for all stages of the decommissioning process, covering aspects such as structure and content of the decommissioning plan, responsibilities of the operator and financial arrangements related to the decommissioning;
(d) Definition of national policies on the safety of facilities and activities including all aspects of decommissioning;
(e) Compilation of a national inventory of radioactive waste taking into account the waste streams produced in the country, including waste streams arising from decommissioning, so as to establish the prioritization of operational activities;
(f) Selection of appropriate strategies for safe decommissioning and for the management of the associated radioactive waste;
(g) Involvement of agencies and technical experts with a major interest in safety, decommissioning and safe management of radioactive waste (interested parties) to make an assessment of the required legislation and to establish or guide the drafting of the legislation;
(h) Availability or development of supporting technical competencies to assure efficient decommissioning and safe management of radioactive waste;
(i) Implementation of a regulatory system including requirements for notification, issuing of authorizations, conduct of inspections and enforcement of regulatory requirements.

3.3. OVERLAPPING JURISDICTIONS

The implementation of a decommissioning project involves a broad range of activities and is therefore a multi-disciplinary issue. Some aspects will be subject to control by the regulatory body, but many other aspects are likely to fall within the jurisdictions of other governmental authorities. Examples of such jurisdictions are:

– Health and safety (dangerous chemicals, radiation protection, industrial safety, fire protection, management of non-radioactive waste);
– Radioactive waste management;
– Environment (discharges, environmental impact assessment of facilities);
– Structures (building codes);
– Transport (transport regulations);
– Mining (mine safety, mine environment).

In many States, governmental authorities responsible for areas such as health and safety, environmental protection and mining existed prior to the establishment of a regulatory body responsible for radiation protection and safety (including decommissioning and radioactive waste management). It is therefore important that the legislation provides a clear allocation of responsibilities between the various authorities. In particular, the powers and responsibilities of the regulatory body need to be clearly defined in the relevant legislation.

Mechanisms to resolve conflicts of jurisdiction between governmental authorities and to avoid gaps and overlaps also need to be put in place. Where necessary, memoranda of understanding between authorities may be formulated for purposes of clarifying the responsibilities of each authority, how the authorities will work together in a coordinated manner, and which authority will act as the lead agent for a given aspect of the decommissioning process. In addition to these legal mechanisms, however, good personal communication between officers of the various governmental authorities is probably the most efficient method for avoiding or resolving issues of overlapping jurisdiction.

4. REGULATORY PROCESS

4.1. SCOPE OF REGULATION

The legal and regulatory framework needs to clearly specify those exposure situations, facilities, activities and materials that are to be included in the scope of regulation, in accordance with the requirements set out in Part 3 of the General Safety Requirements (IAEA Safety Standards Series No. GSR Part 3) [3]. Exposures that are deemed to be not amenable to control, such as those from ^{40}K in the body and cosmic radiation at the surface of the earth, need to be specifically excluded from the overall scope of the legal and regulatory framework.

For practices and sources within practices that fall within the scope of regulation, the legal and regulatory framework has to make provision for the government or regulatory body to determine which of these are to be exempted from some or all of the regulatory requirements. The exemption criteria and exemption levels specified in Part 3 of the General Safety Requirements [3] provide the basis for such a provision. Similarly, the legal and regulatory framework has to make provision for the regulatory body to approve which sources, including materials and objects, within notified or authorized practices may be cleared from regulatory control, using as the basis for such approval the clearance criteria or clearance levels specified in Part 3 of the General Safety Requirements [3].

4.2. RESPONSIBILITY FOR PROTECTION AND SAFETY

National legislation provides the statutory basis for establishing requirements for protection and safety for all exposure situations falling within the scope of the legal and regulatory framework. One of the more fundamental requirements in this regard is that the prime responsibility for protection and safety rests with the person or organization responsible for

facilities and activities that give rise to radiation risks [3]. The identification of the responsible person or organization is generally addressed in the regulations. The responsible person or organization, in addition to submitting a notification to the regulatory body, may also have to apply for an authorization to conduct the practice. The authorization may take the form of a registration or a licence. In terms of the graded approach to regulation, the decision as to which of these requirements will apply in a given situation will depend on the characteristics of the practice or the source within a practice, and on the likelihood and magnitude of exposures. In the case of authorized practices, the regulations provide the means for placing on registrants and licensees whatever obligations are necessary for ensuring the protection and safety of workers and members of the public.

4.3. FRAMING OF REGULATORY REQUIREMENTS

There may be various ways in which the requirements of the relevant IAEA safety standards can be incorporated into regulations. The government or regulatory body, when developing regulations, may identify the most practicable options and compare the advantages and disadvantages of each before selecting the best option as a regulatory requirement. The way in which a requirement is formulated and incorporated into the regulations can have a significant influence on the regulatory and financial burden on registrants and licensees.

5. REGULATIONS AND GUIDANCE

5.1. REGULATIONS

5.1.1. Purpose

Regulations are generally promulgated by a government minister or other relevant authority such as the regulatory body, as specified under the law. Whereas the law provides the general framework within which a certain activity or type of activity may take place, the regulations give specific requirements on how the law is to be applied in practice. Nevertheless, regulations are still by necessity general in their application. They may apply to particular types of industrial activity but are not usually specific to any one facility or activity. The more detailed requirements that apply to a particular facility or activity are more appropriately specified as a set of conditions in the authorization granted to the facility or activity concerned.

The principal purpose of establishing regulations is to codify legal requirements of general applicability. Regulations provide the means for establishing administrative requirements such as those for notification, authorization, inspection and enforcement as well as the technical requirements that are deemed essential for ensuring protection and safety of workers, members of the public and the environment. By providing well founded and clear statements of administrative and technical requirements, regulations serve to provide consistency and stability in the regulatory process.

While regulations are commonly more technical than the laws under which they fall, they form an important part of the legal and regulatory framework. Their purpose is to achieve safety through the establishment of detailed requirements regarding the application of the law and to provide a framework for more detailed conditions and requirements to be incorporated into individual authorizations. By providing a general framework, they also help to avoid arbitrary decisions that may otherwise be taken on a case by case basis and that would make a uniform application of the law more difficult.

5.1.2. Development

The relevant requirements established in the various publications in the IAEA Safety Standards Series (for instance Part 6 of the General Safety Requirements [4] in the case of decommissioning), with any necessary adaptations to take account of factors such as national situations, technical resources and the scale of the facilities concerned, provide the basis for the development of regulations. It is important that the government or the regulatory body, as appropriate, consults with interested parties and takes account of relevant national and international experience. Particular care needs to be taken to ensure that the text of regulations:

– Is consistent with, and closely linked to, the law under which they fall;
– Is clear, easy to understand, unambiguous and precise;
– Covers all necessary aspects;
– Avoids conflicts with other national regulations or laws;
– Does not give rise to unrealistic conditions of authorization.

Due account also needs to be taken of any international conventions to which the State is a party, and of internationally recognized standards that may be relevant, such as those published by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

5.1.3. Updating

It is important that regulations are reviewed from time to time and amended where necessary. Amendments need to be considered in response to new scientific information, advances in technology, operational and regulatory experience, feedback from registrants and licensees, changes in international standards, and changes in national legislation. Information obtained from both national and international activities also needs to be taken into account.

5.1.4. Performance regulations versus prescriptive regulations

The development of regulations of the type that might be needed for decommissioning and management of radioactive waste will involve a balance between meeting two different needs:

– The need for flexibility to permit easy adaptation of the regulations to evolving circumstances and technology;
– The need to include detailed requirements that make it easy to determine when the requirements are being met.

‘Performance’ regulations, meeting the former need, are more general and simply specify the overall safety requirements and basic operational parameters (that is, ‘what’ is to be accomplished in order to achieve the safety objectives). They can be made applicable to a range of activities and, if carefully drafted, do not need to be changed frequently to keep up to date with changing technology. However, they need to be interpreted in relation to each different situation. This requires a higher level of general knowledge and experience on the part of the regulatory body and the registrant or licensee.

‘Prescriptive’ regulations, meeting the latter need, are more specific and therefore have less inherent flexibility. They prescribe in greater detail what to do to comply with legal requirements and achieve safety objectives and also how to go about this in order to achieve an adequate level of safety. The regulations may be activity based or may set out defined limits and provide the regulatory body and the registrant or licensee with clearly defined requirements for a particular practice. Prescriptive regulations in principle facilitate the

performance of reviews and inspections by the regulatory body. They enable the authorization and inspection process to focus on simple verification of compliance. However, a highly prescriptive approach can have an undesirable side effect in that it can encourage a simple 'checking-of-compliance culture' rather than a 'safety culture' if positive steps are not taken to prevent this from happening. Prescriptive regulations require a more detailed knowledge and considerable experience of the particular activity in question by the drafters of the regulations. They are narrowly applicable to a specific situation and may need to be amended relatively frequently to keep pace with technological changes. They are best suited to widespread practices where the equipment and procedures do not vary significantly.

In practice, regulations will usually contain both performance requirements and prescriptive requirements, but can often be characterized as being predominantly performance regulations or predominantly prescriptive regulations. Some States have a strongly prescriptive approach to all their regulations and others do not. The approach adopted depends on national preferences expressed at the policy and strategy levels and on the knowledge and experience of the regulatory body and of registrants and licensees.

5.2. REGULATORY GUIDES

Regulatory guides are normally issued by the regulatory body to provide detailed operational and technical guidelines in order to ensure that legislative and regulatory requirements are met. They communicate to a registrant or licensee what the regulatory body considers to be good practice. They may also provide assistance in interpreting performance based regulations. As the name suggests, a regulatory guide is normally intended to provide guidance rather than to impose more prescriptive requirements.

The level of detail in regulatory guides may vary from one State to another and is influenced by, for instance, the number and extent of facilities and activities. In some States, guidance is given on a case by case basis, but such a system is likely to be applicable only when one or two similar facilities are involved.

Because of the level of detail involved, regulatory guides may be subject to relatively frequent revision and amendment in response to technological developments (for instance advances in dismantling and decontamination techniques in the case of decommissioning), to changes in international standards, or to changes in national policy, laws or regulations.

6. FUNCTIONS OF THE REGULATORY BODY

Parts 1 and 3 of the General Safety Requirements [2, 3] set out the main responsibilities and functions of the regulatory body. Among the more important of these are:

- The granting of exemptions from certain regulatory requirements in accordance with the exemption criteria and exemption levels specified in Part 3 of the General Safety Requirements [3];
- The granting of authorizations;
- The imposition of safety requirements in addition to those contained in the regulations by means of conditions placed on an authorization;
- The carrying out of inspections.

The following additional responsibilities of the regulatory body that are more specific to decommissioning are set out in Part 6 of the General Safety Requirements [4]:

(a) Establishing criteria and the timeframe for the process of authorization for decommissioning;
(b) Establishing requirements for conducting radiological surveys for determining levels of contamination at the facility;
(c) Establishing requirements relating to the criteria for safety, protection of workers and the public, and protection of the environment during the decommissioning of facilities, including criteria for clearance of material from regulatory control in accordance with national policy;
(d) Establishing requirements and criteria for termination of the authorization for decommissioning and especially when facilities and/or sites are released with restrictions on their future use;
(e) Establishing requirements for financial assurance to be provided by the registrant or licensee with respect to the decommissioning, and for a mechanism to ensure that adequate resources will be available when necessary for safe decommissioning, in cases where the government has delegated these responsibilities to the regulatory body;
(f) Establishing requirements for planning for decommissioning, including:
    (i) Specifying the typical content of decommissioning plans and supporting documents for review or approval;
    (ii) Establishing the review and approval process (as prescribed in national regulations) and the applicable timeframe;
(g) Implementing the review and approval process;
(h) Providing interested parties with an opportunity to comment on the final decommissioning plan and supporting documents before their approval, on the basis of national regulations;
(i) Inspecting and reviewing decommissioning actions, ensuring that such actions are in accordance with the decommissioning plan, and taking enforcement actions in the case of non-compliance with the national legal and regulatory framework or with the registration or licence conditions and safety requirements established by the regulatory body;
(j) Establishing requirements for the collection and retention of records and reports relevant to decommissioning, and for preserving information about the activities that have been conducted at the site;
(k) Evaluating a decommissioned facility to determine whether the end state criteria have been met;
(l) Terminating the authorization for decommissioning when the registrant or licensee has demonstrated that the end state criteria have been met.

Also, it is important for the regulatory body to provide information on regulatory activities to relevant interested parties and, where appropriate, coordinate such activities with those of international and national bodies in other States that are involved in protection and safety and in the decommissioning of facilities [2].

7. MODEL REGULATIONS

7.1. INTRODUCTION

The model regulations set out in this section are based primarily on Part 6 of the General Safety Requirements [4] and illustrate the typical structure and content of regulations on decommissioning and on the management of the associated radioactive waste. In order to be adaptable to a variety of situations in a variety of States, these model regulations make reference to the graded approach to regulation and have been designed to be as clear and simple as possible. They give examples of the topics to be covered and of the way in which they are covered, but they are not the only way in which the requirements and guidance

established by the IAEA may be adopted. These model regulations would in any case have to be adapted to the national legal framework of the State concerned.

The notes in italics appearing at various locations within the text of these model regulations are explanatory and not necessarily intended for incorporation into any regulations based on this model. The notes are directed at those involved in the drafting or reviewing of regulations and explain technical or procedural details that might need to be considered by the regulatory body or by the registrant or licensee during the implementation of the relevant requirements.

7.2. MODEL REGULATIONS

[Insert title of the regulations]

The regulatory body [insert name, address, telephone/fax/email on the cover or at the beginning of the regulations].

Note:
If useful, provide similar information about departments within the regulatory body, e.g. Licensing, Inspection, and Administration.

These Regulations are issued under the following authority: [insert name of authority].

Note:
Cite the legislation or other legal authority that provides the basis for the regulations.

PART I - GENERAL PROVISIONS

Article 1: Entry into force

These Regulations shall come into force on __ [insert date] __.

Note:
Further details of this Article would be specific to the legal system of the State.

Article 2: Purpose

1. The purpose of these Regulations is to establish the safety requirements applicable to all aspects of the decommissioning of a facility, including the planning, conduct and completion of decommissioning actions and the termination of the authorization for those actions.

2. These Regulations are not intended to relieve a registrant or licensee from the duty to take any additional actions as may be appropriate and necessary to protect the health and safety of people.

Article 3: Scope

1. These Regulations apply to the decommissioning of nuclear power plants, research reactors and other nuclear installations; facilities involving NORM, including facilities for the mining and processing of radioactive ore; medical, industrial and research facilities in which radioactive materials and sources are produced, received, used and stored; facilities for predisposal radioactive waste management such as treatment, conditioning and storage facilities; and other supporting facilities associated with radioactive waste management.

2. These Regulations do not apply to radioactive waste disposal facilities, including engineered NORM waste containments. However, requirements for the decommissioning of supporting buildings and services of such facilities do apply.

3. These Regulations do not address the remediation of areas contaminated by residual radioactive material arising from past activities that:

(a) Were never subject to regulatory control, or
(b) Were subject to regulatory control in a manner that is not in accordance with the relevant national regulations.

They also do not address the remediation of areas affected by a nuclear or radiological emergency, after the emergency has been declared over.

4. These Regulations apply to the control of radiological hazards and risks resulting from decommissioning.

5. Security and safeguards aspects are outside the scope of these Regulations and shall be handled in accordance with [insert a reference to the relevant regulations].

Notes:
1) The scope of the regulations may be modified according to the needs of the State.
2) Requirements for the closure of radioactive waste disposal facilities, including engineered NORM waste containments, are established in Ref. [11].
3) The management of fresh nuclear fuel and spent nuclear fuel and radioactive waste generated during the operational phase of a facility are not usually considered part of decommissioning. These are addressed as part of the operation of the facility and are outside the scope of these regulations. However, the management of radioactive waste from decommissioning is within the scope of these regulations.
4) Many of the requirements established in these regulations can also be applied to decommissioning after an accident has occurred or a situation has arisen that has resulted in serious damage to, or the contamination of, a facility, or simply after the premature shutdown of a facility.
5) Non-radiological hazards, such as industrial hazards, are outside the scope of these regulations unless they cause radiological risks, and need to be handled in accordance with other relevant regulations. Such hazards require due consideration in the planning and implementation process, in the safety assessments and environmental impact assessments, and in the estimation of costs and the provision of financial resources for the decommissioning project.
6) Particular attention needs to be given to requirements pertaining to the interface between radiation safety and nuclear security.

Article 4: Definitions

Authorization: A permission granted by the regulatory body to a person, natural or juridical, who has submitted an application to carry out an activity or practice. An authorization may take the form of a registration or licence. Authorization can be terminated when demonstration of compliance with the conditions of the authorization for decommissioning of the facility (in particular, meeting the end state criteria) is provided.

Decommissioning: The administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility (except for the part of a disposal facility

in which the radioactive waste is emplaced, for which the term 'closure' instead of 'decommissioning' is used).

Decommissioning actions: The procedures, processes and work activities (for example, decontamination and/or removal of structures, systems and components) as described in the approved decommissioning plan. Decommissioning actions are considered completed when the approved end state criteria have been met. They are carried out to achieve a progressive and systematic reduction in radiological hazards now and in the future without imposing undue burdens on future generations.

Disposal: The emplacement of radioactive waste in an appropriate facility without the intention of retrieval.

Facility: Buildings, and their associated land and equipment, in which radioactive material was or still is produced, processed, used, handled or stored on a scale with such a degree of hazard and risk that consideration of protection and safety is required. 'Land' includes the surface, subsurface soil horizons and any surface or subsurface water or aquifers potentially affected by the radioactive material.

Graded approach: (1) For a system of control, such as a regulatory system or a safety system, a process or method in which the stringency of the control measures and conditions to be applied is commensurate, to the extent practicable, with the likelihood and possible consequences of, and the level of risk associated with, a loss of control. (2) An application of safety requirements that is commensurate with the characteristics of the practice or source and with the magnitude and likelihood of the exposures.

Licence: An authorization granted by the regulatory body on the basis of a safety assessment and accompanied by specific requirements and conditions to be met by the licensee.

Licensee: The holder of a current licence granted for an activity or practice, who has recognized rights and duties for the activity or practice, particularly in relation to protection and safety.

NORM (naturally occurring radioactive material): Radioactive material containing no significant amounts of radionuclides other than naturally occurring radionuclides, including material in which the activity concentrations of the naturally occurring radionuclides have been changed by a process.

Permanent shutdown: The state of a facility at which its intended operation has ceased and will not be recommenced.

Protection and safety: The protection of people against exposure to ionizing radiation or due to radioactive material and the safety of sources, including the means for achieving this, and the means for preventing accidents and for mitigating the consequences of accidents if they do occur.

Radioactive material: Material designated in national law or by a regulatory body as being subject to regulatory control because of its radioactivity.

Registration: A form of authorization for practices of low or moderate risks whereby the person or organization responsible for the practice has, as appropriate, prepared and submitted a safety assessment of the facilities and equipment to the regulatory body. The practice or use is authorized with conditions or limitations as appropriate.

Registrant: The holder of a current registration.

Regulatory body: An authority or a system of authorities, designated by the government of a State as having legal authority for conducting the regulatory process, including issuing authorizations, and thereby regulating nuclear, radiation, radioactive waste and transport safety.

Regulatory control: Any form of control or regulation applied to facilities or activities by a regulatory body for reasons related to radiation protection or to the safety of radiation sources.

Storage: The holding of radioactive sources, spent fuel or radioactive waste in a facility that provides for their/its containment with the intention of retrieval.

Notes:
1) *Terms used in these regulations are intended to be interpreted in accordance with Refs [3, 19].*
2) *The regulatory body needs to consider country specific terminology when implementing these model regulations into the national legal framework.*

Article 5: Additional requirements

The registrant or licensee shall comply with requirements imposed by the regulatory body in the conditions of authorization or by order, in addition to those established in these Regulations.

Article 6: Interpretation

Except as specifically authorized, no official interpretation of these Regulations can be made binding on the regulatory body by any officer or employee of the regulatory body other than a written interpretation by [identify who in the regulatory body is authorized to make the official interpretation that will be binding].

PART II - PROTECTION OF PEOPLE AND THE ENVIRONMENT

Article 7: Protection and safety

1. Exposure during decommissioning shall be considered to be a planned exposure situation and all the relevant requirements of the national regulations on radiation protection established in [insert the title of the national regulations] shall be applied accordingly during all decommissioning activities.

2. The relevant dose limits for the exposure of workers and members of the public shall be applied during decommissioning.

3. The registrant or licensee shall ensure that protection and safety are optimized. For occupational exposure and public exposure, the registrant or licensee shall ensure that, where appropriate, relevant dose or risk constraints are used in the optimization of protection and safety during decommissioning.

~~4.~~ Provision shall be made during decommissioning for protection against, and for reduction of, exposure due to an incident.

Note:

If the incident or the particular situation is of such a nature as to warrant remediation or to require confinement of releases of radioactive material under emergency conditions, other safety requirements will also apply [4, 20].

5. For occupational exposure and public exposure, the registrant or licensee shall ensure that all relevant factors are taken into account in the optimization of protection and safety in a manner that contributes to achieving the following objectives:

(a) To establish measures for protection and safety that are optimized for the prevailing circumstances, with account taken of the available options for protection and safety as well as the nature, likelihood and magnitude of exposures;
(b) To establish criteria, on the basis of the results of the optimization, for the restriction of the likelihood and magnitudes of exposures by means of measures for preventing accidents and for mitigating the consequences of those that do occur.

Article 8: Graded approach

1. The registrant or licensee shall apply a graded approach to all aspects of the decommissioning process, consistent with the magnitude of the possible radiation risks arising from the decommissioning.

2. The registrant or licensee shall document the way in which the graded approach is implemented to ensure that the level of analysis, documentation and actions implemented to comply with the requirements for protection and safety are commensurate with:

(a) The type and purpose of the facility (e.g. the complexity of the facility, the products or process involved);
(b) The particular characteristics of the facility;
(c) The stage of a facility within its lifetime (e.g. age, status, condition);
(d) The relative importance to safety, safeguards and security and the magnitude of any hazards involved;
(e) The relative importance of radiological and non-radiological hazards;
(f) Any other relevant factors.

3. The application of the graded approach shall be reassessed during planning, as the development of the decommissioning plan progresses, and during implementation of the decommissioning plan, as the decommissioning actions progress, depending on factors such as the complexity of the facility and the hazards involved in the decommissioning actions.

4. When applying the graded approach the registrant or licensee shall ensure that the decommissioning plan, including the safety assessment carried out in or for any particular facility or activity, is consistent with the magnitude of the possible radiation risks arising from the facility or activity.

5. The safety assessment referred to in Article 9 shall be planned, organized, applied, audited and reviewed in a way that is in accordance with the graded approach.

6. When a phased approach is applied to a decommissioning project, the registrant or licensee shall apply a graded approach in the identification of:

(a) The nature and extent of phases in terms of complexity and duration;
(b) The work to be performed and related techniques in each phase;
(c) The hazards and risks related to each phase;

(d) Interdependencies between phases;
(e) Any milestones of the registration or licensing process and the periodic update of the decommissioning plan and supporting documents.

Note:
Consideration needs to be given to the application of the graded approach to the decommissioning process by means of the following:
- *Applying a graded approach to the implementation of the system of protection and safety;*
- *Conducting the decommissioning actions and applying regulatory oversight in a manner that is commensurate with the hazards and risks involved;*
- *Applying a graded approach to the application of the requirements for predisposal management of radioactive waste in a manner commensurate with the hazards, the complexity of the facilities and activities, and the characteristics of the waste, such that these requirements are applied as necessary and appropriate.*

Article 9: Assessment of safety

1. The registrant or licensee shall assess the safety of decommissioning actions for all facilities for which decommissioning is planned or ongoing.

2. The decommissioning plan shall be supported by a safety assessment addressing the planned decommissioning actions and any incidents associated with such actions, including accidents that may occur or situations that may arise during decommissioning.

3. The safety assessment shall demonstrate that the planned decommissioning actions meet all applicable safety requirements.

4. The registrant or licensee shall, before starting the safety assessment, confer with the regulatory body to establish the scope and level of detail of the safety assessment for the facility or activity and the resources that need to be directed to the safety assessment.

5. The registrant or licensee shall prepare the safety assessment so as:

(a) To identify all of the ways in which exposures could be incurred, account being taken of the effects of external events as well as of events directly involving the decommissioning actions;
(b) To determine the expected magnitudes and likelihood of exposures in normal situations during decommissioning and, to the extent reasonable and practicable, make an assessment of potential exposures;
(c) To assess the adequacy of the provisions for protection of workers and members of the public and the provisions for safety, including registrant or licensee response to incidents and accidents.

6. The registrant or licensee, in developing the safety assessment, shall:

(a) Document how regulatory requirements and safety criteria are met to support the authorization of the proposed decommissioning actions;
(b) Include a systematic evaluation of the nature, magnitude and likelihood of hazards and their radiological consequences for workers, the public and the environment for planned activities and for accident conditions;
(c) Quantify the systematic and progressive reduction in radiological hazards to be achieved through the conduct of the decommissioning actions;
(d) Identify the safety measures, limit controls and conditions that will need to be applied to

the decommissioning actions to ensure that the relevant safety requirements and criteria are met and maintained throughout the decommissioning;

(e) Where relevant, demonstrate that the institutional controls applied after decommissioning will not impose an undue burden on future generations;
(f) Provide input to on-site and off-site emergency planning, where applicable, and to safety management arrangements;
(g) Identify training needs for decommissioning and competences for staff performing decommissioning actions;
(h) Demonstrate the competence of the staff for the planned actions.

Note:
The requirements and guidance given in Refs [6, 21] provide the basis for the preparation of the safety assessment by the registrant or licensee.

7. The registrant or licensee shall periodically review the safety of the facility being decommissioned at a frequency established by the regulatory body. Within this review the registrant or licensee shall take into account:

(a) Any changes that may significantly affect the safety of the facility or decommissioning actions;
(b) Significant developments in knowledge and understanding (such as developments arising from research or decommissioning experience);
(c) Emerging safety issues due to a regulatory concern or a significant incident;
(d) Changes in the input data used in the safety analysis that may have significant implications for safety.

8. An independent verification of the safety assessment shall be conducted on behalf of the registrant or licensee, consistent with the national regulatory framework, prior to finalizing the safety assessment and before submitting it for regulatory review. The verification shall be undertaken in a systematic manner and the approach, findings and recommendations should be clearly documented and, if required, submitted to the regulatory body.

9. The independent verification shall ensure that:

(a) The input data and assumptions used are valid;
(b) The assessment accurately reflects the actual state of the facility and the decommissioning actions;
(c) The safety measures derived from the safety assessment are adequate for the decommissioning actions;
(d) The safety assessment is kept updated to reflect changes to the facility and the development of knowledge and understanding about it.

10. Where a phased approach to decommissioning is used, an independent verification shall be performed to ensure that the safety assessment for each phase is consistent with the overall safety assessment. Prior to commencing a new phase of decommissioning, an independent verification shall be performed to ensure that the safety assessment has been appropriately updated.

11. The development, verification and internal approval of the safety assessment for decommissioning as part of the decommissioning plan shall be part of the management system of the facility.

Note:
It is important that the regulatory body establishes (for instance, in the conditions of authorization) the regular interval for review and possible update of the safety assessment, taking into account the type and complexity of the individual decommissioning project. It is also important to undertake a review and possible update of the safety assessment when the methods or approaches to decommissioning are changed significantly.

Article 10*:* Planned discharges and their control

1. The registrant or licensee shall declare, in the decommissioning plan, its intention to manage discharges during the decommissioning, to assess their radiological consequences and to manage them in accordance with (insert title of relevant national regulations).

2. The registrant or licensee shall:

(a) Obtain authorization from the regulatory body for any discharges of radioactive material into the environment during the decommissioning actions;
(b) Determine the characteristics of the discharges and the possible locations and methods of discharge;
(c) Determine all significant exposure pathways by which discharged radionuclides could give rise to exposure of members of the public;
(d) Assess the doses to the representative person due to the planned discharges;
(e) Assess the radiological environmental impacts in a manner that is integrated with the features of the system of protection and safety;
(f) Promptly report to the regulatory body any unplanned discharges or exceeding of approved discharge limits, in the manner specified in the conditions of authorization.

Notes:
1) Further requirements and guidance on radioactive discharges can be found in Refs [3, 22].
2) The management of discharges includes the monitoring of discharges.
3) The reporting of unplanned discharges may also be subject to the requirements of other legal instruments.

Article 11: Clearance of material from regulatory control

1. The registrant or licensee shall declare in the decommissioning plan any intention to clear material from regulatory control in accordance with [insert reference to relevant regulations]. The registrant or licensee shall describe the methodology to be used for clearing such material, including any decontamination process involved.

2. The registrant or licensee shall set out in the decommissioning plan a formal mechanism, including rigorous control measures, for ensuring that the radioactive material to be cleared complies with the relevant clearance criteria or clearance levels approved by the regulatory body.

3. The registrant or licensee shall record, within a management system, relevant information on material that has been cleared and shall report this information to the regulatory body in accordance with regulatory requirements.

Notes:
1) It is a duty of the regulatory body to approve which sources, including materials and objects, within notified or authorized practices may be cleared from regulatory control

using, as the basis for such approval, criteria for clearance or any clearance levels specified by the regulatory body on the basis of these criteria [3].

2) *The general criteria for clearance [3] are that:*
   (a) *Radiation risks arising from the cleared material are sufficiently low as not to warrant regulatory control, and there is no appreciable likelihood of occurrence for scenarios that could lead to a failure to meet the general criterion for clearance; or*
   (b) *Continued regulatory control of the material would yield no net benefit, in that no reasonable control measures would achieve a worthwhile return in terms of reduction of individual doses or reduction of health risks.*
3) *Material may be cleared without further consideration provided that in reasonably foreseeable circumstances the effective dose expected to be incurred by any individual owing to the cleared material is of the order of 10 μSv or less in a year. To take into account low probability scenarios, a different criterion can be used, namely that the effective dose expected to be incurred by any individual for such low probability scenarios does not exceed 1 mSv in a year. Material may also be cleared without further consideration provided that the radionuclide activity concentration does not exceed the relevant value specified in Schedule I of Part 3 of the General Safety Requirements [3].*

Article 12*:* On-site and off-site monitoring

1. The registrant or licensee shall apply, review and modify as necessary its on-site and off-site monitoring programme, as described in the decommissioning plan and/or its supporting documents to ensure that changes to the facility, specific hazards, and effluents associated with decommissioning are monitored and addressed appropriately.

2. In the case of deferred dismantling, the registrant or licensee shall ensure that a programme for monitoring and surveillance is in place throughout the period of deferral.

3. If the approved decommissioning end state involves ongoing restrictions on the future use of the site, appropriate controls and programmes for monitoring and surveillance shall be established and maintained for the optimization of protection and safety, and protection of the environment. These controls and programmes shall be subject to approval by the regulatory body.

4. The registrant or licensee shall assign clear responsibility for implementing and maintaining these controls and programmes to ensure compliance with the restrictions on the future use of the site.

Notes:

1) *It is important that the decommissioning plan specifies the requirement for on-site and off-site monitoring during decommissioning.*
2) *The purpose of on-site monitoring is to provide information to identify and assist in mitigating the radiological risks and to enable the planning of specific decommissioning actions. It is important that all potential release points are monitored. Where monitoring is conducted for the purposes of assessing the doses received by decommissioning workers, workplace monitoring may need to be supplemented by individual monitoring where appropriate, adequate and feasible, particularly for workers in controlled areas [3]. An on-site monitoring programme typically involves the use of:*
   (a) *Monitoring equipment for dose rate and contamination surveys for workplaces, components and materials during decontamination, dismantling and handling;*
   (b) *Monitoring procedures and equipment for packaging and handling of radioactive waste within the site, as well as for transport of the waste off the site;*

(c) Monitoring equipment for timely screening of large quantities of radioactive material with low activity concentrations for purposes of clearance;
(d) Equipment and procedures to monitor the distribution of radionuclides in the installation including airborne contaminants.

3) The off-site monitoring programme inherited from the operational period will need to be modified in order to be appropriate for the conditions existing during decommissioning.

4) The control, monitoring and recording of discharges of radionuclides via airborne and liquid pathways is a requirement either of the regulatory body or of another relevant authority.

PART III - MANAGEMENT OF DECOMMISSIONING

Article 13: Responsibilities of the registrant or licensee

1. The registrant or licensee shall have the prime responsibility for all aspects of protection and safety during decommissioning. This responsibility cannot be delegated.

2. The registrant or licensee shall plan for decommissioning and shall conduct the decommissioning actions in compliance with the authorization for decommissioning and with other requirements derived from the national legal and regulatory framework.

3. The registrant or licensee shall identify other parties that have specified responsibilities for the application of these Regulations.

Note:
These parties may include, as appropriate:
– *A radiation protection officer;*
– *Contractors, qualified experts or any other party to whom a principal party has assigned specific activities;*
– *Workers.*

4. The responsibilities of the registrant or licensee include the following:

(a) Establishing protection and safety objectives;
(b) Selecting a decommissioning strategy as the basis for preparing, maintaining and updating the decommissioning plan throughout the lifetime of the facility;
(c) Preparing and submitting an initial decommissioning plan and subsequent updates for review by the regulatory body and/or other relevant authority;
(d) Establishing, implementing and maintaining the technical and organizational_measures that are needed for ensuring protection and safety during the decommissioning actions and for compliance with all applicable requirements of these Regulations;
(e) Establishing, implementing and maintaining a management system;
(f) Estimating the cost of decommissioning actions and providing financial assurances and resources to cover the costs associated with safe decommissioning, including management of the resulting radioactive materials and radioactive waste;
(g) Notifying the regulatory body or other relevant authority prior to permanent shutdown of the facility;
(h) Managing the decommissioning project, conducting decommissioning actions and ensuring oversight of the actions conducted by contractors;
(i) Ensuring the safe management and control of any remaining operational waste from the facility and all waste from decommissioning, and disposing of such waste in accordance with the regulatory requirements;

(j) Ensuring that the facility is maintained in a safe configuration during any period of transition from permanent shutdown to the start of decommissioning actions;
(k) Developing, implementing and documenting a protection and safety programme commensurate with the radiation risks associated with the exposure situation and sufficient to ensure compliance with the requirements of these Regulations;
(l) Performing safety assessments and environmental impact assessments in support of decommissioning actions, in accordance with the requirements of these Regulations and other applicable regulations;
(m) Preparing and implementing appropriate safety procedures, including emergency plans where appropriate;
(n) Ensuring that properly trained, qualified and competent staff are available for the decommissioning project;
(o) Performing radiological surveys in support of decommissioning;
(p) Verifying that the approved end state criteria have been met by performing a final radiological survey;
(q) Preparing and submitting a final decommissioning report to the regulatory body;
(r) Keeping records and submitting reports as required by the regulatory body.

5. If the performance of specific tasks is to be delegated to contractors, the registrant or licensee shall ensure that:

(a) The authorities and responsibilities for the specific tasks are clearly defined;
(b) Interfaces and communication routes are clearly defined;
(c) The work of contractors is appropriately controlled so that it is conducted safely and meets regulatory requirements.

Notes:
1) The registrant or licensee for decommissioning is fully responsible for all aspects of the decommissioning, even in the case where the operational phase of the facility involved a different registrant or licensee. Accordingly, any transfer of responsibility from one registrant or licensee to another needs to be planned and executed carefully.
2) For such a transfer of responsibilities:
(a) It is important that the registrant or licensee involved in the operational phase retains the necessary resources, expertise and knowledge for decommissioning and keeps records and documentation relevant to the siting, design, construction, commissioning, operation and decommissioning processes so that such information can be transferred to any new registrant or licensee involved in the decommissioning phase;
(b) The responsibilities for preparation of the decommissioning plan need to be clearly defined;
(c) It is important that a complete set of records and drawings is maintained by the original registrant or licensee and passed to the new registrant or licensee at the appropriate time.
(d) Responsibility for the safety of the facility remains with the original registrant or licensee until the new registration or licence, covering the decommissioning actions, has been granted.

Article 14: Management system

1. The registrant or licensee shall ensure that protection and safety is effectively integrated into the overall management system of the organization for all aspects of decommissioning.

2. The registrant or licensee shall demonstrate commitment to protection and safety at the highest levels within its organization.

3. A management system shall provide a single framework for the arrangements and processes necessary to address all aspects relevant to decommissioning.

4. The management system shall enable the planning and implementation of decommissioning actions to ensure that decommissioning will be conducted safely.

5. When the registrant or licensee delegates the performance of defined tasks to contractors, the management system shall contain provisions to ensure that the work of contractors is appropriately specified and controlled and is conducted safely.

6. The registrant or licensee shall ensure that individuals performing the safety assessment and decommissioning have the necessary skills, expertise and training. The registrant or licensee shall make arrangements for ensuring that the institutional knowledge about the facility is preserved and made accessible and, as far as possible, that key staff from the facility are retained.

7. The registrant or licensee shall ensure that all individuals performing decommissioning actions are aware of their responsibility to inform management of any concerns about protection and safety. The registrant or licensee shall ensure that processes are put in place to grant the necessary levels of authority and support to such individuals should they decide to suspend decommissioning actions for reasons of protection and safety.

8. The registrant or licensee shall control the decommissioning process through the use of written procedures. Such procedures shall be subject to review and approval by the responsible protection and safety personnel working for the registrant or licensee. A methodology for issuing, modifying and terminating work procedures shall also be established.

9. If the registrant or licensee changes during the lifetime of the facility, the process of transferring responsibility for protection and safety should be such as to ensure that responsibility for protection and safety during the decommissioning phase remains clearly defined.

10. The registrant or licensee shall ensure that the management system is designed and implemented in a manner that enhances protection and safety by:

(a) Applying the requirements for protection and safety coherently with other regulatory requirements;
(b) Ensuring that protection and safety is not compromised by other requirements;
(c) Providing for the regular assessment of performance for protection and safety and the application of lessons learned from experience;
(d) Promoting the necessary safety culture.

11. The registrant or licensee shall ensure that protection and safety elements of the management system are commensurate with the complexity of and the radiation risks associated with the decommissioning actions.

12. The registrant or licensee shall demonstrate the effective fulfilment of the requirements for protection and safety in the management system to ensure that health,

environmental, security, quality and economic requirements are not considered separately from safety requirements, in order to help preclude their possible negative impact on safety.

13. The registrant or licensee shall implement within the management system a decision making process to address any modifications to techniques and tools during the conduct of decommissioning actions and to determine if these modifications need any additional review and approval by the regulatory body. The scope, roles and rules of this decision making process and the key experts involved in this process shall be documented in the decommissioning plan and records of decisions shall be kept and made available to the regulatory body as required.

Notes:

1) *The regulatory body needs to ensure that the registrant or licensee establishes a robust management system for decommissioning. Guidance for the management system can be found in Refs [23–25].*
2) *By covering all aspects of decommissioning, the management system is capable of taking into account ongoing changes to the state of the facility during the decommissioning process.*
3) *The main goal of the management system is to achieve and enhance safety of decommissioning actions by:*
   (a) *Bringing together in a coherent manner all the requirements for managing the organization;*
   (b) *Describing the planned and systematic actions necessary to provide adequate confidence that all these requirements are satisfied;*
   (c) *Ensuring that health, environmental, security, quality and economic requirements are not considered in isolation from safety requirements, to help preclude their possible negative impact on safety.*
4) *It is important that the management system programme for decommissioning includes periodic exercises and evaluation of emergency plans with subsequent revision as necessary.*
5) *The management system programme for decommissioning is generally submitted to the regulatory body as a part of the decommissioning plan, which in turn forms part of the application for a decommissioning registration or licence.*
6) *Management system documentation for decommissioning generally includes a description of:*
   (a) *The decommissioning policy of the registrant or licensee;*
   (b) *The organizational structure of the registrant or licensee;*
   (c) *The functional responsibilities, accountabilities, levels of authority and interactions of those managing, performing and assessing the decommissioning actions;*
   (d) *The interactions with relevant external organizations;*
   (e) *The processes and supporting information that explain how decommissioning actions are to be prepared, reviewed, carried out, recorded, assessed and improved.*

Article 15: Safety culture

The registrant or licensee shall promote and maintain a safety culture by:

(a) Promoting individual and collective commitment to protection and safety at all levels of the organization;
(b) Ensuring a common understanding of the key aspects of safety culture within the organization;

(c) Providing the means by which the organization supports individuals and teams in carrying out their tasks safely and successfully, with account taken of the interactions between individuals, technology and the organization;
(d) Encouraging the participation of workers and their representatives and other relevant persons in the development and implementation of policies, rules and procedures dealing with protection and safety;
(e) Ensuring accountability of the organization and of individuals at all levels for protection and safety;
(f) Encouraging open communication with regard to protection and safety within the organization and with relevant parties, as appropriate;
(g) Encouraging a questioning and learning attitude and discouraging complacency with regard to protection and safety;
(h) Providing means by which the organization continually seeks to develop and strengthen its safety culture, including appropriate training.

Note:
The maintenance of the safety culture is not only a task for the registrant or licensee and its contractors, but also for other principal parties such as the regulatory body.

Article 16: Human factors

1. The registrant or licensee shall develop, implement and maintain a human factors programme to ensure that:

(a) New equipment and the development of procedures facilitate safe decommissioning and use of equipment, minimize the possibility that human errors will lead to accidents, and reduce the possibility that indications of normal conditions and abnormal conditions will be misinterpreted;
(b) Appropriate systems, structures, components and procedures are in place:
- To reduce, as far as practicable, the possibility that human error or inadvertent action could give rise to accidents or other incidents leading to the exposure of any person;
- To provide means for detecting human errors and for correcting them or compensating for them;
- To facilitate protective actions and corrective actions in the event of failures of safety systems or failures of protective measures.

2. All employees shall be informed at least annually of the importance of effective safety measures and be trained in their implementation as appropriate.

3. Training programmes shall be developed, evaluated periodically (e.g. annually) and updated as necessary.

Article 17: Inventory and records

1. The registrant or licensee shall establish, maintain, archive and maintain accessible key records relevant to the development of the decommissioning plans, their subsequent updates and the final decommissioning report in accordance with national regulations.

2. The registrant or licensee shall maintain up to date records of the materials and waste generated, stored in the facility, or transferred to another authorized facility, specifying their quantities, characteristics, treatment methods and destination.

Notes:

1) Record keeping during operation for future decommissioning may cover:
   (a) Documents and records relating to decommissioning, and the performance of all work activities and operations for decommissioning;
   (b) An inventory of sealed sources and radiation generators;
   (c) Records of doses arising from occupational exposures;
   (d) Records relating to safety at the facility;
   (e) An inventory of radioactive waste;
   (f) Records of events, including non-routine releases of radioactive material to the environment;
   (g) The transfer of radioactive sources and radioactive waste;
   (h) The testing of instruments and safety systems, and calibrations carried out in accordance with regulatory requirements.
2) The decommissioning expertise and knowledge obtained during the implementation of the project needs to be preserved and relevant records and documentation kept (i.e. records relevant to the design, construction, operation and decommissioning processes) so that such information can be kept by the registrant or licensee or transferred to any supporting or successor operating organization.
3) It is important that the regulatory body specifies a period for which the registrant or licensee is to maintain the documents and records associated with the decommissioning actions, as well as the quality of documents and records to be prepared and kept by the registrant or licensee.

Article 18: Involvement of interested parties

1. The person or organization applying for an authorization for decommissioning should provide interested parties with an opportunity to comment on the decommissioning plan before submitting its application to the regulatory body.

2. The registrant or licensee should inform interested parties of any site restrictions.

3. The registrant or licensee should inform interested parties of the results of monitoring and surveillance.

4. The registrant or licensee should address inputs from the public before requesting a termination of the authorization for decommissioning.

Notes:
1) The regulatory body needs to provide interested parties (e.g. relevant authorities, interested members of the public, local or governmental authorities) with an opportunity to participate in the process of decision making on the release of the site from regulatory control.
2) The involvement of interested parties is important in the determination of acceptable end state criteria for release of the site. Consultation with interested parties could be valuable in, for example, the selection of the scenarios and definition of the institutional control measures, the critical groups and the end state of the site under consideration for release. Different approaches for involving interested parties could be applied; one approach is through the process of assessing the impact of the release of the site on the environment. The relevant interested parties also need to be involved before a final decision or authorization is given by the regulatory body.

Article 19: Requirements for reporting to the regulatory body

1. The registrant or licensee shall:

(a) Submit a report to the regulatory body at approved intervals on the progress of the decommissioning actions, including a summary of the monitoring results for workers and members of the public and the status of the decommissioning fund;
(b) Submit a report to the regulatory body at approved intervals on discharges to the environment and promptly report any discharges exceeding the authorized limits;
(c) Notify the regulatory body as soon as practicable, but not later than [insert time period as defined in national regulations, typically 24 hours] after the discovery of any incident or accident;
(d) Submit to the regulatory body, within [insert time period as defined in national regulations, typically 30 days] after discovery of the incident or accident, a written report which states the cause of the incident or accident and includes details of exposures, corrective measures and any other relevant information;
(e) Promptly inform the regulatory body of any abnormal situations which lead or could lead to an increase of public exposure;

2. Any non-compliance with these Regulations with significant implications for safety shall be communicated to the regulatory body within [insert time period as defined in national regulations, typically 24 hours].

3. Reports on the radioactive waste generated during decommissioning shall be submitted to the regulatory body in accordance with the requirements of the relevant regulations.

4. The registrant or licensee shall ensure that information on normal decommissioning performance as well as abnormal conditions and events significant to protection and safety is disseminated or made available, as appropriate, to the regulatory body and other interested parties, as specified by the regulatory body.

PART IV - DECOMMISSIONING STRATEGY

Article 20: Selecting a decommissioning strategy

1. The registrant or licensee is responsible for selecting a decommissioning strategy for its facility. The decommissioning strategy shall be consistent with the national policy and strategy on radioactive waste management and with regulatory requirements.

2. The preferred decommissioning strategy shall be immediate dismantling.

Note:
This requirement is based on a general consensus among Member States that the preferred decommissioning strategy is immediate dismantling [4]. However, there may be situations in which immediate dismantling is not a practicable strategy when all relevant factors are considered.

3. The decommissioning strategy shall be well documented including a description of the options, the overall timescales for the decommissioning of the facility and the end state after completion of all decommissioning actions. The reasons for the preferred option shall be explained and justified.

Notes:

1) *The end state of the decommissioning process describes the objective of the overall decommissioning project. In general, there are two possible end states of decommissioning projects – so called 'green field' and 'brown field'. The former refers to a situation where the site and/or buildings of the decommissioned facility can be used without any restriction and can be released from regulatory control. The latter refers to the situation where the site and/or building can be used with restrictions and with some regulatory oversight.*
2) *The end state will be subject to the requirements of national regulations, especially the requirements governing the release of a facility from regulatory control (see also Article 35).*

4. The registrant or licensee shall demonstrate that, for the strategy selected, the facility will be maintained in a safe configuration at all phases of decommissioning and will reach the specified decommissioning end state as defined in the approved decommissioning plan, and that no undue burdens will be imposed on future generations.

5. If the shutdown of a facility is sudden, the decommissioning strategy shall be reviewed on the basis of the situation that initiated the sudden shutdown to determine whether revision of the strategy is required. If shutdown is caused by an accident, the facility shall be brought to a safe configuration before the decommissioning plan is implemented.

6. For sites with more than one facility, a site strategy for decommissioning shall be developed to ensure that interdependences between the facilities are taken into account in the individual decommissioning plans for each facility. This site strategy shall be made available to the regulatory body.

PART V - FINANCING OF DECOMMISSIONING

Article 21: Financing of decommissioning

1. The responsibilities of the registrant or licensee shall include:

(a) Estimating the cost of the decommissioning actions, including management of the resulting radioactive waste;
(b) Providing financial assurances and resources to cover the costs associated with safe decommissioning, including management of the resulting radioactive waste. Financial resources shall be made available in accordance with relevant national regulations.

2. The cost estimates for the decommissioning actions shall be updated periodically so as to be consistent with the most recent update of the decommissioning plan.

3. The amount of financial assurance shall be consistent with the most recent cost estimate for the decommissioning actions. The necessary financial resources for providing this assurance shall be put in place as soon as possible in a manner approved by the regulatory body or other relevant authority.

4. In the event of a sudden shutdown of the facility, provisions shall be put in place to enable the accumulated financial resources to be used for decommissioning when they are needed.

5. If the decommissioned facility is to be released with restrictions on the future use of the site, financial assurances shall be made available for ongoing monitoring, surveillance and control of the site throughout the specified time period.

Notes:

1) *Responsibilities with respect to financial provisions for decommissioning are generally set out in the relevant national legislation. These provisions include the establishment of a mechanism to ensure the provision of adequate financial resources for safe and timely decommissioning.*
2) *A registrant or licensee may choose from among various mechanisms for ensuring compliance with the financial assurance requirements for decommissioning. The following financial assurance methods may be considered:*
   (a) Prepayment;
   (b) Surety, insurance or guarantee;
   (c) External sinking fund coupled with a surety method or insurance;
   (d) Statement of intent by a governmental body at the federal, state or local level.
3) *The demonstration of financial assurance for decommissioning generally includes:*
   (a) An up to date, detailed estimate of the costs of decommissioning and, where post-decommissioning institutional control has to be implemented, the ongoing costs of any monitoring, surveillance, maintenance and controls subsequent to such termination;
   (b) One or more financial assurance mechanisms (including supporting documentation);
   (c) A comparison of the cost estimate with the level of coverage provided by the financial assurance mechanism, taking into account the ongoing cost of any post-decommissioning institutional control;
   (d) A description of the means to be employed for adjusting the cost estimate and associated funding level before, during (and, where appropriate, beyond) the period over which the decommissioning is to be carried out;
4) *If financial assurance for the decommissioning of an existing facility has not yet been obtained, adequate financial resources need to be put in place as soon as possible.*

PART VI - PLANNING OF DECOMMISSIONING

Article 22: Planning of decommissioning

1. The registrant or licensee shall take decommissioning into account when siting, designing, constructing, commissioning, operating and modifying the facility in order to facilitate decommissioning and record keeping and to minimize contamination, activation and/or the accumulation of waste.

2. At the siting stage during the establishment of a new facility, a background survey of the site, including obtaining information on radiological conditions, shall be performed. The baseline data obtained shall be updated prior to the commissioning of the facility. In the case of an existing facility for which no such background survey has been made in the past, data from analogous and undisturbed areas with similar characteristics shall be used.

Note:
This information will be used to determine background radiological conditions.

3. For a new facility, planning for decommissioning shall begin early in the siting/design stage and shall continue throughout the lifetime of the facility up to and including the decommissioning stage itself.

4. Based on the established decommissioning strategy, the registrant or licensee shall establish an initial decommissioning plan for the facility and shall submit this to the regulatory body together with the application for authorization to construct, commission, and operate the facility.

5. This initial decommissioning plan shall:

(a) Identify decommissioning options to demonstrate the feasibility of decommissioning;
(b) Confirm that sufficient financial resources will be available for decommissioning;
(c) Identify categories and estimate quantities of waste that will be generated during decommissioning;
(d) Confirm that decommissioning can be safely conducted using techniques that are proven or under development;
(e) Cover environmental aspects of the decommissioning, such as the management of waste.

6. The initial decommissioning plan shall identify major existing structures, systems and components (SSCs) that may be used during decommissioning, their changes or replacements and the need for new SSCs performing specific safety functions during decommissioning. The initial decommissioning plan shall also identify the need for existing and new facilities to carry out decommissioning and waste management.

7. The initial decommissioning plan shall be supported by an appropriate safety assessment for the decommissioning actions, the details of which are commensurate with the characteristics and status of the facility, consistent with a graded approach.

Note:
At the stage of the siting/design of a new facility, the aim of the safety assessment developed to support the initial decommissioning plan is to ensure the technical feasibility of decommissioning, to address the general safety considerations and to consider the results of technical feasibility studies and feedback of experience from similar facilities already decommissioned.

8. During the operation of the facility, the decommissioning plan and related safety assessment shall be updated by the registrant or licensee at least every five years or as otherwise specified by the regulatory body. The update of the decommissioning plan shall consider as necessary:

(a) The operational experience gained;
(b) The lessons learned from the decommissioning of similar facilities;
(c) New or revised safety requirements;
(d) Advances in technological developments relevant to the selected decommissioning strategy;
(e) The occurrence of incidents or situations giving rise to consequences relevant to decommissioning;
(f) Any change to the decommissioning strategy;
(g) Any significant deviations from the cost estimate and the scheduled programme.

9. For existing facilities where there is no initial decommissioning plan, a suitable plan for decommissioning reflecting the operational status of the installation shall be prepared by the registrant or licensee and shall be periodically reviewed and updated every five years or as otherwise specified by the regulatory body.

10. If a facility is permanently shut down and/or is no longer used for its intended purpose, the final version of the decommissioning plan shall be submitted to the regulatory body for approval within a period defined by the regulatory body (typically within two to five years of permanent shutdown).

Notes:

1) *Planning for decommissioning begins at the siting/design stage and continues throughout the lifetime of the facility until the final decommissioning plan has been approved and the authorization for decommissioning has been granted.*
2) *The regulatory body would be expected to develop a detailed guide on the format and content of the initial decommissioning plan. An example of the table of contents of a decommissioning plan is given in Appendix I.*
3) *The initial decommissioning plan needs to highlight the importance of the following considerations at the design stage:*
   - *(a) Minimizing the amount of construction materials and SSCs that will end up having to be managed as radioactive waste during the decommissioning;*
   - *(b) Minimizing the amount of decontamination that will be needed at the decommissioning stage by:*
     - *(i) Avoiding the use of pipelines in floors and walls that may give rise to undetected leakage,*
     - *(ii) Avoiding the use of underground SSCs such as tanks, vaults and drainage systems that may give rise to undetected leakage;*
     - *(iii) Separating SSCs for the management of radioactive material from those for the management of non-radioactive material;*
     - *(iv) Using straight ducts and piping systems so as to minimize the creation of deposits and sludges;*
     - *(v) Where the use of straight ducts and piping systems cannot be avoided, using curves or shallow bends in pipes rather than sharp elbows and T fittings;*
     - *(vi) Using leakage monitoring systems.*
   - *(c) Modular design of SSCs to facilitate the removal and segregation of contaminated items;*
   - *(d) Selection of materials with minimal or zero content of any trace elements that may give rise to activation products from the neutron flux in the reactor core, its components and surrounding SSCs;*
   - *(e) Use of materials and surface layers that facilitate decontamination;*
   - *(f) Restrictions on the use of dangerous substances;*
   - *(g) Adequate access and space for dismantling of construction materials and SSCs and, if needed, for in situ segmentation of large SSCs;*
   - *(h) Dismantling and decontamination by remote control techniques.*
4) *Regardless of the stage of a facility within its lifetime, the initial decommissioning plan will contain the same basic elements, although the relative depth and level of detail may vary substantially. For example, the description of decommissioning actions and the safety assessment will be less detailed in an initial decommissioning plan prepared early in the life of a facility than in the final update prepared at the time just before the start of decommissioning.*
5) *Although the level of detail in the initial decommissioning plan will necessarily be lower than that in the final update, many of the aspects can be considered in a conceptual fashion. A generic study showing the feasibility of decommissioning may suffice for the initial decommissioning plan, particularly in standardized installations. The applicable regulations might require the costs and the means of financing the decommissioning work to be addressed in the decommissioning plan.*

6) *It is important for the decommissioning plan to be reviewed by the regulatory body at specified intervals not exceeding five years. Updating of the decommissioning plan may become necessary as a result of such reviews and will always become necessary in the event of significant changes, for instance when changes in an operational process occur.*

Article 23: Transition from operation to decommissioning

1. The registrant or licensee shall ensure that the facility is maintained in a safe configuration during any period of transition, if applicable, following permanent shutdown and until the approval of the final decommissioning plan.

2. The registrant or licensee shall remove operational radioactive waste and/or nuclear material present in the facility prior to the conduct of decommissioning actions and shall transport such material to an authorized facility. If such removal is not possible during the period of transition, the registrant or licensee shall address the removal of such materials as part of the decommissioning plan.

Notes:
1) *Planning for the transition needs to begin during the operating period of the facility.*
2) *Depending on the decision of the regulatory body and on national regulations, an operating registration or licence may remain in effect during all or part of the transition period.*
3) *It is essential for the cost of managing operational radioactive waste and/or nuclear material to be included in the decommissioning cost estimate, unless such cost is to be accounted for separately, and to be taken into account when determining the associated financial assurance.*

3. The registrant or licensee shall notify the regulatory body as soon as the decision has been made to permanently shut down the facility.

Notes:
1) *A definition of 'decision on permanent shutdown' needs to be provided in the regulations to ensure that the requirements become enforceable by the regulatory body.*
2) *The regulatory body may require additional notifications from the operator e.g. on the removal of nuclear fuel from a reactor.*

Article 24: Final update of the decommissioning plan

1. Within a period established by the regulatory body, the registrant or licensee shall prepare and submit a final update of the decommissioning plan and supporting documents for review and approval by the regulatory body prior to granting the authorization to conduct the decommissioning actions.

Note:
Typically within two to five years after permanent shutdown, the registrant or licensee would be required to submit to the regulatory body its application for a decommissioning authorization with the final update of the decommissioning plan. During this period (often called the transition period), the authorization for operation of the facility remains in place unless the regulatory body has approved modifications of the authorization on the basis of a reduction in the hazards associated with the facility. During this period, some preparatory actions for decommissioning can be performed in accordance with the authorization for operation of the facility or a modified authorization.

2. During preparation of the final version of the decommissioning plan the registrant or licensee shall examine the facility and determine the quantity and type of radioactive and other hazardous material at the facility (e.g. activated and contaminated structures, systems and components) to ensure that the final version of the decommissioning plan and the associated safety assessment reflect the real conditions of the facility.

3. Where contamination (including contamination in subsurface soils and groundwater) or radioactive waste from the operation remains at the facility after permanent shutdown, the registrant or licensee shall include these in the detailed characterization surveys.

4. As part of the preparation of the final version of the decommissioning plan the registrant or licensee shall check and update the relevant facility drawings and other documents to reflect changes that have been made during the operational period and/or the transition period.

Note:
The examination of the facility generally includes also the characterization of the site for the purpose of evaluating and preventing the potential migration of radionuclides.

5. The final version of the decommissioning plan and supporting documents shall cover:

(a) The selected decommissioning strategy;
(b) The schedule, type and sequence of decommissioning actions;
(c) The waste management strategy applied, including clearance, the proposed end state and how the registrant or licensee will demonstrate that the end state criteria have been met;
(d) The storage and disposal of the waste from decommissioning;
(e) The timeframe for decommissioning;
(f) Financing for the completion of decommissioning.

Article 25: Documents in support of the decommissioning plan

1. If so requested by the regulatory body, the registrant or licensee shall submit any supporting documents supplementing individual parts of the decommissioning plan to provide more detailed information that will facilitate the approval process.

Note:
Typical supporting documents are:
(a) Safety analysis report for decommissioning;
(b) Decommissioning limits and conditions;
(c) Emergency preparedness and response plan;
(d) Environmental impact assessment;
(e) Radiation protection programme, including environmental monitoring;
(f) Radioactive waste management plan;
(g) Radiological characterization report;
(h) Remediation plan (see Appendix III);
(i) Final radiological survey plan;
(j) Report on financial assurance;
(k) Security plan (this may be restricted for security reasons).

2. The registrant or licensee shall submit to the regulatory body for approval the emergency preparedness and response plan during decommissioning, reflecting the emergency arrangements and any updates.

Notes:

1) *These model regulations do not focus on emergency response. Requirements for preparedness and response for a nuclear or radiological emergency are established in Refs [3, 20].*
2) *For purposes of preventing adverse health effects in workers and the public, the registrant or licensee would normally be required to maintain emergency response arrangements commensurate with the expected hazards and to report events significant to safety to the regulatory body in a timely manner.*
3) *The registrant or licensee would be expected to perform on-site emergency exercises at regular intervals and to report the results to the regulatory body. Some of these exercises would include the participation to the extent possible of external organizations concerned with any on-site emergency.*
4) *If the safety assessment indicates that there is a reasonable likelihood of an emergency affecting either workers or members of the public during decommissioning actions, the registrant or licensee will generally be required to prepare an emergency plan for the protection of people and the environment, as well as procedures and analytical tools in order to be able to perform the functions specified to meet the requirements for emergency response established in the relevant national regulations.*

3. The registrant or licensee shall adopt appropriate measures to ensure physical protection and security at the facility undergoing decommissioning to prevent unauthorized access of individuals and unauthorized removal of radioactive material, as established in [insert title of the relevant national regulations]. These requirements shall be implemented in such a way as not to compromise the safety of the facility.

Article 26: Other requirements

1. The registrant or licensee transporting radioactive material generated during the decommissioning of a facility shall comply with the requirements of [insert title of national regulations on transport of radioactive material].

Note:
Depending on the legal framework, different regulatory requirements may exist for on-site and off-site transport.

2. If safeguarded nuclear material is present during the decommissioning, the registrant or licensee shall comply with the applicable nuclear safeguards requirements, as established in [insert title of the relevant national regulations]. These requirements shall be implemented in such a way as not to compromise the safety of the facility.

Article 27. Deferred dismantling

In the case of deferred dismantling, the registrant or licensee shall, in addition to complying with the requirements of Article 24, demonstrate in the decommissioning plan that:

(a) In the case of a nuclear facility, such facility will be made passively safe as far as reasonably practical before entering the deferral period and that the need for active safety systems, monitoring, and human intervention will be minimized accordingly;
(b) In the case of a nuclear facility, the dismantling of such facility can be conducted safely and reliably after end of the deferral period;
(c) The care and maintenance programme will ensure safety during the deferral period and will not impair future decommissioning;

(d) The financial resources for the deferral period and the following period of dismantling are ensured.

PART VII - CONDUCT OF DECOMMISSIONING

Article 28. Start of decommissioning actions

1. The registrant or licensee shall not commence decommissioning actions until the authorization for decommissioning has been granted by the regulatory body.

2. The registrant or licensee shall not commence any additional or altered decommissioning actions until the decommissioning plan has been updated and the updated version has been approved by the regulatory body.

Note:
It is important for the regulatory body to clearly define the difference between transition activities and decommissioning actions.

Article 29. Phased approach

1. When the registrant or licensee implements a phased approach to conduct decommissioning actions, all phases necessary to reach the final end state shall be described in the decommissioning plan and supporting documents.

2. The registrant or licensee shall, within the decommissioning plan in addition to the requirements of (1):

(a) Provide an overview of the decommissioning of the facility;
(b) Describe the content, schedule and timeframe of each phase;
(c) Make provision for an overarching safety assessment;
(d) Specify the end state criteria of each phase;
(e) Demonstrate that earlier phases do not jeopardize the conduct of any later phase.

3. The registrant or licensee shall, at least for the first phase, develop a detailed safety assessment as part of the decommissioning plan.

4. The registrant or licensee shall develop detailed safety assessments for each phase gradually and consistently with the progressive implementation of the decommissioning process.

Article 30: Management of structures, systems and components (SSCs)

1. The registrant or licensee shall determine whether the SSCs identified for decommissioning actions fulfil the safety functions required of them.

2. The registrant or licensee shall identify and classify SSCs, and shall reclassify SSCs as their importance for safety changes during the course of the decommissioning actions. The registrant or licensee shall reflect this classification and/or reclassification in the decommissioning plan and supporting documents.

Notes:

1) *As part of the safety assessment, safety functions and their associated SSCs need to be identified, both for planned decommissioning actions and for accident conditions, and their suitability and sufficiency demonstrated. The safety functions that have to be fulfilled during decommissioning comprise a combination of safety functions that were needed during operation of the facility and additional functions that will be needed as a result of the specific decommissioning actions proposed (e.g. fire detection and suppression during cutting and grinding activities).*
2) *The effects of decommissioning on the safety functions at adjacent facilities also need to be evaluated. In addition, dismantling of major facility structures during decommissioning may involve the deliberate destruction and removal of engineered SSCs that had fulfilled specified safety functions during the operation of the facility (e.g. containment, shielding, ventilation, cooling). If these safety functions are still required, either the associated SSCs will need to be maintained in an appropriate state during decommissioning or, if this is not practicable, these functions will need to be provided by suitable alternative means (e.g. tents, temporary facilities, fire systems, electrical systems, administrative procedures) for as long as is required on the basis of the safety assessment. The appropriateness of alternative means of fulfilling these functions needs to be demonstrated and any change of safety functions during decommissioning needs to be justified in advance before its implementation.*

3. The registrant or licensee shall maintain and update the list of SSCs important to safety. Existing SSCs may be reclassified and progressively removed from service and dismantled as the decommissioning progresses, provided that the inspection and maintenance programme for the facility is updated accordingly.

Note:
An SSC can be reclassified if its safety function during decommissioning changes. The reclassification has to be in compliance with regulatory requirements and approved by the regulatory body accordingly.

4. Installation and use of new SSCs shall be consistent with the decommissioning plan.

5. The registrant or licensee shall address the ageing of SSCs and other equipment significant to safety by establishing, if necessary, provisions for their maintenance, testing and inspection.

6. The registrant or licensee shall record, store, analyse and review data on maintenance, testing, surveillance and inspection of SSCs and other equipment relevant to safety.

Article 31: Feedback of decommissioning experience

The registrant or licensee shall establish and implement arrangements for the feedback of decommissioning experience through the collection, screening, analysis and documentation of experience and events at the facility in a systematic way and in a manner that improves and ensures safe decommissioning. Relevant experience and information on events related to safety, radiation protection and waste management gained from similar national and international decommissioning projects shall also be considered as appropriate.

Notes:
1) *It is important for the regulatory body to share with other registrants and licensees at similar facilities the decommissioning experience gained from good practices and lessons learned from incidents and accidents.*

2) *The feedback of experience and lessons learned from facilities and activities and, where relevant, from elsewhere are key means of enhancing safety.*

Article 32: Radioactive waste management

1. The registrant or licensee shall manage in the frame of its radioactive waste management programme all waste streams, including disused radioactive sources, according to the national policy and strategy on radioactive waste management.

2. Before embarking on decommissioning actions, the registrant or licensee shall ensure the availability of adequate processing and storage capabilities and transport packages for the radioactive waste generated by the decommissioning.

Note:
If radioactive waste is to be stored on the site after decommissioning has been completed, the waste storage facility will become subject to authorization that will entail, among other things, compliance with requirements for decommissioning of that storage facility.

3. The registrant or licensee shall make arrangements for the disposal of radioactive waste arising from operational activities that remains at the facility and radioactive waste that will be generated during decommissioning.

4. Should sufficient disposal capacity not be available at the time of decommissioning, the registrant or licensee shall store the radioactive waste safely in accordance with the relevant requirements.

5. The registrant or licensee shall develop, document and implement arrangements for characterization, segregation, volume reduction and further management of the particularly large quantities and different types of radioactive waste and other residues generated during decommissioning, including remediation of contaminated areas, in accordance with the requirements set by the regulatory body and with the national strategy for the management of radioactive waste.

Note:
The regulatory body and the registrant or licensee need to be aware of the fact that as a good practice it is considered that all sources such as radioactive waste and spent fuel are removed from the facility before the start of decommissioning actions.

6. The registrant or licensee shall maintain up to date records of the radioactive waste that is generated, stored at the facility and/or transferred to another authorized facility, specifying its quantities, characteristics, treatment methods and destination, including any radioactive waste and materials that are released from regulatory control.

Notes:
1) *These model regulations do not focus on radioactive waste management. Related requirements can be developed in more specific regulations (see for instance Ref. [26]).*
2) *Decommissioning of nuclear reactors invariably involves the generation of large amounts of radioactive waste. In the course of decommissioning, waste will be generated in forms that are different from materials and wastes of the types routinely handled during the operational phase of a nuclear power plant or research reactor. Subject to safety considerations, generation of radioactive waste shall be kept to the minimum practicable.*
3) *For example, appropriate decontamination and dismantling techniques and the recycling of residues or their use as by-products can reduce the amount of radioactive waste that*

has to be managed. A large part of the radioactive residues arising during the decommissioning process may be sufficiently low in activity concentration for regulatory control to be wholly or partly removed, subject to compliance with criteria established by the regulatory body. Some residues may be suitable for disposal in normal landfill sites, while some residues such as contaminated steel and concrete may be suitable for recycling or use outside the nuclear industry.

4) *Special attention needs to be given to the management of non-radioactive and hazardous waste.*

Article 33: Management of the facility during a period of deferral

1. Before the start of the period of deferral the registrant or licensee shall:

(a) Demonstrate that the facility complies with the conditions for the period of deferral as described in the decommissioning plan;
(b) Implement a care and maintenance programme developed as part of the decommissioning plan, the implementation of which ensures safety and does not impair future decommissioning phases.

2. The registrant or licensee shall review periodically the care and maintenance programme for its appropriateness during the period of deferral focusing on the ageing of SSCs.

Notes:

1) *Maintenance is important during the period of deferral since part of the safety of the installation may rely on systems that have to retain their capability to perform for extended periods of time. Periodical monitoring of all the safety related components of the installation needs to be incorporated into the decommissioning plan.*
2) *It is important that the regulatory body conducts periodic inspections to verify that the facility continues to comply with the conditions for the period of deferral as described in the decommissioning plan.*

PART VIII - COMPLETION OF DECOMMISSIONING ACTIONS AND TERMINATION OF AUTHORIZATION FOR DECOMMISSIONING

Article 34: Completion of decommissioning actions

1. On completion of the decommissioning actions, the registrant or licensee shall prepare all relevant records concerning the former presence of the facility on the site and the nature of the activities conducted thereat, for the benefit of a future user of the site after its release from regulatory control.

Notes:

1) *Within the regulatory framework the responsibility for operating a system for maintenance of records on completion of decommissioning actions needs to be clearly defined. In some situations the responsibility rests with the registrant or licensee, but in other situations the responsibility may be transferred to another organization or even an authority.*
2) *The following list gives examples of the kind of records that need to be retained in an integrated manner, commensurate with the complexity of the facility being decommissioned and the associated hazard potential:*
   (a) The decommissioning plan and any subsequent amendments;
   (b) The facility characterization report;

(c) *The final decommissioning report;*
(d) *Quality assurance records, including relevant completed work packages and work plans;*
(e) *Engineering drawings, photographs and videos produced during and on completion of decommissioning;*
(f) *Manufacturing and construction as-built records, including engineering drawings for any installation or construction work done to assist with, or as part of, decommissioning;*
(g) *Dose records;*
(h) *Radiation survey results;*
(i) *Details of significant abnormal events during decommissioning and the actions taken.*

2. Based on these records, the registrant or licensee shall prepare a final decommissioning report and submit it to the regulatory body for review and approval to demonstrate that the end state of the facility as specified in the decommissioning plan has been reached.

3. Where the future use of the site is restricted, the registrant or licensee shall specify in the final decommissioning report any ongoing controls and monitoring and surveillance programme needed.

Notes:
1) *The regulatory body needs to review the final decommissioning report and evaluate the end state to ensure that all regulatory requirements and end state criteria, as specified in the decommissioning plan and in the authorization for decommissioning, have been met. This review and evaluation enables the regulatory body to decide on the termination of the authorization for decommissioning and on the release of the site from regulatory control.*
2) *The responsibility for implementing and maintaining any ongoing monitoring and surveillance programmes in case of restricted release needs to be clearly defined in the regulatory framework. In some situations the responsibility rests with the registrant or licensee, while in other situations the responsibility is transferred to another organization or even an authority.*
3) *Appendix II provides an example of a format for a final decommissioning report.*

Article 35: Termination of decommissioning authorization

1. The registrant or licensee shall demonstrate that the end state specified in the final version of the decommissioning plan has been reached and is consistent with the requirements and criteria established in [insert relevant regulations] or by the regulatory body.

2. Inputs from the public shall be addressed by the registrant or licensee before the termination of decommissioning authorization.

3. The registrant or licensee shall apply for the termination of the decommissioning authorization after achieving the proposed end state as described in the final version of the decommissioning plan.

4. Where the registrant or licensee applies for the release of parts of the facility from regulatory control, the remainder of the facility remains subject to regulatory control according to [insert national regulations].

5. Where a site is released with restrictions on use, the registrant or licensee shall:

(a) Ensure that financial resources are available for monitoring, surveillance and control of the facility throughout the necessary time period;
(b) Document the restrictions within the final decommissioning report;
(c) Establish and ensure that controls and programmes for monitoring and surveillance can be maintained;
(d) Address any inputs from the public.

The ongoing controls and programmes shall be subject to approval by the regulatory body.

Notes:
1) *The duties of the regulatory body with respect to the termination of the decommissioning authorization generally include the following:*
   (a) Establishing requirements and criteria (e.g. 0.3 mSv/a) for termination of the decommissioning authorization, especially when the site is released with restrictions on future use. (Further advice and guidance can be found in Section 2.10 of Ref. [5]);
   (b) Approving the end state of the decommissioning as proposed by the registrant or licensee in the final version of the decommissioning plan;
   (c) Reviewing the final decommissioning report and evaluating the end state to ensure that all regulatory requirements and end state criteria, as specified in the final version of the decommissioning plan and in the decommissioning authorization, have been met;
   (d) On the basis of this review and evaluation, deciding on the termination of the decommissioning authorization and on the release of the site from regulatory control;
   (e) Approving any ongoing controls and programmes for monitoring and surveillance and clearly assigning responsibility for implementing and maintaining them;
   (f) Ensuring that a mechanism is put in place to ensure compliance with the restrictions on the future use of the site including archiving details on such restrictions for the benefit of future generations (e.g. entry in a land register).
2) *For restricted use, the type, extent and duration of the restrictions and controls for release of the site can range from monitoring and surveillance to restriction of access to the site. The restrictions are proposed by the registrant or licensee on the basis of the graded approach and with consideration given to factors such as the type and level of residual contamination after the completion of remediation, the relevant dose constraints and release criteria, and the human and financial resources needed to implement the restrictions and controls. The body responsible for ensuring that the restrictions are maintained and enforced, as well as the way in which the restrictions would be removed when they are no longer necessary, need to be specified in the remediation plan [5].*
3) *For the evaluation of potential radiological consequences associated with a site after its release, all relevant exposure pathways need to be considered. Two main approaches can be taken: either generic release criteria may be provided by the regulatory body for use by the registrant or licensee, or the registrant or licensee may derive site specific release criteria and submit them to the regulatory body for approval. If an optimization process is used to develop release criteria, this process allows for iteration between individual steps, with account taken of the optimization factors.*

Article 36: On-site storage of radioactive material

If remaining radioactive material, which may include radioactive waste, is to be stored on the site after completion of the decommissioning actions, a revised or new authorization for the

storage facility is required. This authorization shall include requirements for the decommissioning of the storage facility.

Note:
Predisposal management of radioactive waste is addressed in Ref. [10].

APPENDIX I - EXAMPLE OF A TABLE OF CONTENTS OF A DECOMMISSIONING PLAN

The decommissioning plan may comprise the following elements:

1. INTRODUCTION
2. FACILITY DESCRIPTION
    - 2.1. SITE LOCATION AND DESCRIPTION
    - 2.2. BUILDING AND SYSTEM DESCRIPTION
        - 2.2.1. Systems and components needed for residual operation, including those relevant for safety
        - 2.2.2. Operation manuals relevant for safety
    - 2.3. RADIOLOGICAL STATUS
        - 2.3.1. Contaminated structures
        - 2.3.2. Contaminated systems and equipment
        - 2.3.3. Surface soil contamination
        - 2.3.4. Subsurface soil contamination
        - 2.3.5. Surface water contamination
        - 2.3.6. Groundwater contamination
    - 2.4 FACILITY OPERATING HISTORY
        - 2.4.1. Authorized activities
        - 2.4.2. Registration or licensing history
        - 2.4.3. Spills and occurrences affecting decommissioning
        - 2.4.4. Previous decommissioning actions
        - 2.4.5. Prior on-site burial
3. DECOMMISSIONING STRATEGY
    - 3.1. ALTERNATIVES CONSIDERED
    - 3.2. RATIONALE FOR CHOSEN STRATEGY
4. PROJECT MANAGEMENT
    - 4.1. LEGAL AND REGULATORY REQUIREMENTS
    - 4.2. PROJECT MANAGEMENT APPROACH
    - 4.3. PROJECT MANAGEMENT ORGANIZATION AND RESPONSIBILITIES
    - 4.4. TASK MANAGEMENT ORGANIZATION AND RESPONSIBILITIES
    - 4.5. TRAINING
    - 4.6. CONTRACTOR SUPPORT
    - 4.7. SCHEDULES
5. DECOMMISSIONING ACTIONS
    - 5.1. CONTAMINATED STRUCTURES
    - 5.2. CONTAMINATED SYSTEMS AND EQUIPMENT
    - 5.3. SOIL
    - 5.4. SURFACE AND GROUNDWATER
    - 5.5. DECOMMISSIONING SCHEDULES
6. SURVEILLANCE AND MAINTENANCE
    - 6.1. EQUIPMENT AND SYSTEMS REQUIRING SURVEILLANCE AND MAINTENANCE
    - 6.2. SCHEDULE FOR SURVEILLANCE AND MAINTENANCE

7. WASTE MANAGEMENT

- 7.1. IDENTIFICATION OF WASTE STREAMS
- 7.2. SOLID RADIOACTIVE WASTE
- 7.3. LIQUID RADIOACTIVE WASTE
- 7.4. WASTE CONTAINING BOTH RADIONUCLIDES AND OTHER HAZARDOUS MATERIAL

8. COST OF DECOMMISSIONING

- 8.1. COST ESTIMATE
- 8.2. FUNDING MECHANISMS

9. SAFETY ASSESSMENT

- 9.1. IDENTIFICATION OF RELEVANT SAFETY CRITERIA
- 9.2. OPERATIONAL LIMITS AND CONDITIONS
- 9.3. HAZARD ANALYSIS OF NORMAL DECOMMISSIONING ACTIONS
- 9.4. HAZARD ANALYSIS OF ABNORMAL EVENTS AND INCIDENTS
- 9.5. ASSESSMENT OF POTENTIAL CONSEQUENCES
- 9.6. PREVENTIVE AND MITIGATING MEASURES
- 9.7. RISK ASSESSMENT
- 9.8. COMPARISON OF ANALYSIS RESULTS WITH RELEVANT SAFETY CRITERIA
- 9.9. CONCLUSIONS

10. ENVIRONMENTAL ASSESSMENT

- 10.1. BACKGROUND DATA
- 10.2. DESCRIPTION OF PROJECT
- 10.3. IMPACT ASSESSMENT
- 10.4. EFFLUENT MONITORING PROGRAMME
- 10.5. EFFLUENT CONTROL PROGRAMME

11. HEALTH AND SAFETY

- 11.1. RADIATION PROTECTION PROGRAMME
- 11.2. NUCLEAR CRITICALITY SAFETY
- 11.3. INDUSTRIAL HEALTH AND SAFETY PROGRAMME
- 11.4. AUDITS AND INSPECTIONS
- 11.5. RECORD KEEPING PROGRAMME
- 11.6. OPTIMIZATION ANALYSES AND PROGRAMME
- 11.7. DOSE ESTIMATION AND OPTIMIZATION FOR MAJOR TASKS
- 11.8. CLEARANCE CRITERIA
- 11.9. FINAL RELEASE CRITERIA

12. MANAGEMENT SYSTEM

    12.1. ORGANIZATION
    12.2. QUALITY ASSURANCE ARRANGEMENTS
    12.3. DOCUMENT CONTROL
    12.4. CONTROL OF MEASURING AND TEST EQUIPMENT
    12.5. CORRECTIVE ACTIONS
    12.6. RECORD MANAGEMENT
    12.7. AUDITS AND SURVEILLANCE
    12.8. LESSONS LEARNED PROGRAMME
    12.9. SAFETY CULTURE

13. EMERGENCY PLANNING

    13.1. ORGANIZATION AND RESPONSIBILITIES
    13.2. EMERGENCY SITUATIONS
    13.3. RECORDS

14. PHYSICAL SECURITY AND SAFEGUARDS

    14.1. ORGANIZATION AND RESPONSIBILITIES
    14.2. PHYSICAL SECURITY PROGRAMME AND MEASURES
    14.3. SAFEGUARDS PROGRAMME AND MEASURES (IF ANY)

15. FINAL RADIATION SURVEY

16. INVOLVEMENT OF INTERESTED PARTIES

Details on the format and content can be obtained from IAEA Safety Reports Series No. 45: Standard Format and Content for Safety Related Decommissioning Documents [27].

APPENDIX II - EXAMPLE OF A FORMAT OF A FINAL DECOMMISSIONING REPORT

The format of the final decommissioning report might comprise the following elements:

(1) A description of the facility;
(2) The decommissioning objectives;
(3) The radiological and non-radiological criteria used as a basis for the release of the equipment, buildings or site from regulatory control;
(4) A final dose calculation for any potential occupants of the site after removal of regulatory control;
(5) A description of the decommissioning activities;
(6) A description of any buildings or equipment not decommissioned or partially decommissioned;
(7) The final radiological survey report;
(8) An inventory of radioactive material, including amounts and types of radioactive waste generated during decommissioning and the locations for storage and/or disposal;
(9) An inventory of non-radioactive material, including amounts and types of non-radioactive waste generated during decommissioning and the locations for storage and/or disposal;
(10) An inventory of materials, equipment and premises released from regulatory control;
(11) A list of structures, areas or equipment designated for future use with restrictions;
(12) A comparison of actual volumes of radioactive waste generated during decommissioning activities with the amounts projected in the planning phase;
(13) A summary of any abnormal events and incidents that occurred during decommissioning;
(14) A discussion of the status of the removal of controls and any remaining restrictions on the site, including monitoring and surveillance programmes;
(15) A summary of doses received by workers and members of the public during decommissioning;
(16) The lessons learned during the decommissioning process.
(17) The input received from interested parties and how it was utilized.

The final decommissioning report could consist of several reports. Alternatively, as in the case of simple facilities, this decommissioning final report could be a summary of these reports.

APPENDIX III - EXAMPLE OF A FORMAT OF A SITE REMEDIATION PLAN

The format of the site remediation plan might comprise the following elements:

(1) A characterization of the site (including the site boundaries for purposes of remediation);
(2) The objectives, end state, safety principles and criteria for the remediation and for release of the site from regulatory control;
(3) A description of the proposed remediation activities and the equipment, resources and timescales for their implementation;
(4) A description of the measures taken for the protection of workers and the public;
(5) A safety assessment and an environmental impact assessment for the proposed activities and for the end state after release of the site, including information on and justification of the use of generic or site specific data;
(6) A description of the monitoring measures that will be taken to demonstrate that the end state criteria have been met;
(7) A description of the radioactive waste management activities;
(8) A description of the management system;
(9) Cost estimates for the specified remediation activities in relation to the overall cost of decommissioning;
(10) A description of the arrangements made for emergency preparedness and response;
(11) A description of the final site survey;
(12) A description of the provision for monitoring during and after remediation.

REFERENCES

[1] EUROPEAN ATOMIC ENERGY COMMUNITY, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Governmental, Legal and Regulatory Framework for Safety, IAEA Safety Standards Series No. GSR Part 1 (Rev. 1), IAEA, Vienna (2016).

[3] EUROPEAN ATOMIC ENERGY COMMUNITY, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, WORLD HEALTH ORGANIZATION, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna (2014).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Facilities, IAEA Safety Standards Series No. GSR Part 6, IAEA, Vienna (2014).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Release of Sites from Regulatory Control on Termination of Practices, IAEA Safety Standards Series No. WS-G-5.1, IAEA, Vienna (2006).

[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Assessment for the Decommissioning of Facilities Using Radioactive Material, IAEA Safety Standards Series No. WS-G-5.2, IAEA, Vienna (2008).

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Nuclear Power Plants and Research Reactors, IAEA Safety Standards Series No. WS-G-2.1, IAEA, Vienna (1999).

[8] INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Medical, Industrial and Research Facilities, IAEA Safety Standards Series No. WS-G-2.2, IAEA, Vienna (1999).

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, Decommissioning of Nuclear Fuel Cycle Facilities, IAEA Safety Standards Series No. WS-G-2.4, IAEA, Vienna (2001).

[10] INTERNATIONAL ATOMIC ENERGY AGENCY, Predisposal Management of Radioactive Waste, IAEA Safety Standards Series No. GSR Part 5, IAEA, Vienna (2009).

[11] INTERNATIONAL ATOMIC ENERGY AGENCY, Disposal of Radioactive Waste, IAEA Safety Standards Series No. SSR-5, IAEA, Vienna (2011).

[12] INTERNATIONAL ATOMIC ENERGY AGENCY, Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, INFCIRC/546, IAEA, Vienna (1997).

[13] INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook on Nuclear Law, IAEA, Vienna (2003).

[14] INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook on Nuclear Law, Implementing Legislation, IAEA, Vienna (2010).

[15] INTERNATIONAL ATOMIC ENERGY AGENCY, Independence in Regulatory Decision Making, INSAG-17, IAEA, Vienna (2003).

[16] INTERNATIONAL ATOMIC ENERGY AGENCY, Convention on Physical Protection of Nuclear Material, INFCIRC/274/Rev. 1, IAEA, Vienna (1980).
[17] INTERNATIONAL ATOMIC ENERGY AGENCY, Policies and Strategies for Radioactive Waste Management, IAEA Safety Standards Series No. NW-G-1.1, IAEA, Vienna (2009).
[18] INTERNATIONAL ATOMIC ENERGY AGENCY, Policies and Strategies for the Decommissioning of Nuclear and Radiological Facilities, NW-G-2.1, IAEA, Vienna (2011).
[19] INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Safety Glossary, Terminology Used in Nuclear Safety and Radiation Protection, 2007 Edition, IAEA, Vienna (2007).
[20] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL CIVIL AVIATION ORGANIZATION, INTERNATIONAL LABOUR ORGANIZATION, INTERNATIONAL MARITIME ORGANIZATION, INTERPOL, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, PREPARATORY COMMISSION FOR THE COMPREHENSIVE NUCLEAR-TEST-BAN TREATY ORGANIZATION, UNITED NATIONS ENVIRONMENT PROGRAMME, UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS, WORLD HEALTH ORGANIZATION, WORLD METEOROLOGICAL ORGANIZATION, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSR Part 7, IAEA, Vienna (2015).
[21] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Assessment for Facilities and Activities, IAEA Safety Standards Series No. GSR Part 4 (Rev. 1), IAEA, Vienna (2016).
[22] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulatory Control of Radioactive Discharges to the Environment, IAEA Safety Standards Series No. WS-G-2.3, IAEA, Vienna (2000).
[23] INTERNATIONAL ATOMIC ENERGY AGENCY, Leadership and Management for Safety, IAEA Safety Standards Series No. GSR Part 2, IAEA, Vienna (2016).
[24] INTERNATIONAL ATOMIC ENERGY AGENCY, The Management System for the Processing, Handling and Storage of Radioactive Waste, IAEA Safety Standards Series No. GS-G-3.3, IAEA, Vienna (2008).
[25] INTERNATIONAL ATOMIC ENERGY AGENCY, The Management System for the Disposal of Radioactive Waste, IAEA Safety Standards Series No. GS-G-3.4, IAEA, Vienna (2008).
[26] INTERNATIONAL ATOMIC ENERGY AGENCY, Model Regulations for the Use of Radiation Sources and for the Management of the Associated Radioactive Waste, IAEA-TECDOC-1732, IAEA, Vienna (2013).
[27] INTERNATIONAL ATOMIC ENERGY AGENCY, Standard Format and Content for Safety Related Decommissioning Documents, Safety Reports Series No. 45, IAEA, Vienna (2005).

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Consultants' Meetings

1. First meeting of the project on the Development of Reference Regulations for Decommissioning (CS-47760), IAEA, Vienna, 16–20 December 2013.

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3. Third CS meeting for the project on the Development of Reference Regulations for Decommissioning (CS-49914), Washington DC, 1–5 December 2014.

Technical meeting

Technical Meeting to Review, Develop and Finalize the IAEA Technical Document on Model Regulations for Decommissioning (J9-TM-49912), IAEA, Vienna, 13–16 April 2015.

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