

**SAFETY ASSESSMENT FOR DECOMMISSIONING**

**Annex III**

**Regulatory Review of Safety Assessment for  
Decommissioning of Facilities Using  
Radioactive Material**

**INTERNATIONAL ATOMIC ENERGY AGENCY  
VIENNA**



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## **FOREWORD**

The purpose of Annex III of this report is to provide advice to regulators on a standardized approach to the regulatory review of safety assessments that support decommissioning project proposals or license applications. The prime purpose of regulatory review is to establish that decommissioning activities can be carried out safely and in compliance with safety requirements and criteria for protecting workers, members of the public and the environment. The advice in Annex III is intended to fulfil this purpose, although it may also be of assistance during reviews performed for other purposes such as independent reviews carried out by or on behalf of the operator.

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## 1. INTRODUCTION

### 1.1. BACKGROUND

The importance of safety during decommissioning has been emphasized at various international fora, such as the International Conference on Safe Decommissioning for Nuclear Activities in Berlin (14-18 October 2002) [1]; the Conference on Lessons Learned from the Decommissioning of Nuclear Facilities and the Termination of Nuclear Activities, held in Athens, Greece (11-15 December 2006) [2] and the Nuclear Energy Agency (NEA) International Seminars on Decommissioning in Tarragona, Spain (2-4 September 2003) [3] and Rome, Italy (6-10 September 2004) [4]. In its June 2004 meeting, the Board of Governors of the International Atomic Energy Agency (IAEA) approved an International Action Plan on Decommissioning of Nuclear Facilities [5] which encourages the IAEA to develop an internationally agreed approach to safety assessment of decommissioning and also to develop recommendations for regulators and operators on the preparation and contents of the safety assessment which need to be developed in association with the decommissioning plan<sup>1</sup> for each facility being decommissioned. Appropriate safety assessment is required [6] to support the decommissioning plan covering the proposed decommissioning activities and abnormal events that may occur during decommissioning. The assessment shall address occupational exposures and potential releases of radioactive substances with resulting exposure of the public.

In addition the first review meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [7, 8] also highlighted the importance of safety of decommissioning. The evaluation and demonstration of safety is recognized as one of the set of requirements presented in the Safety Fundamentals [9], IAEA Safety Requirements [6] and Safety Guides [10, 11, 12] published by the IAEA over the last few years. Supporting reports addressing record keeping [13], dismantling techniques [14], and on the standard content of safety related decommissioning documents [15] have also been developed that provide specific information about technical subjects.

International projects to develop recommendations for the demonstration of safety of near surface disposal facilities have been carried out in recent years under the auspices of the IAEA, including the ISAM (Improvement of Safety Assessment Methodologies for Near Surface Disposal Facilities) [16] and ASAM (Application of Safety Assessment Methodologies for Near Surface Disposal Facilities) [17] projects.

In light of these developments, a new international project addressing the Evaluation and Demonstration of Safety of Decommissioning of Facilities Using Radioactive Material (DeSa) was initiated by the IAEA in November 2004. This project aimed to develop an equivalent level of detailed recommendations in the field of decommissioning, taking into account international experience and lessons learned. To this end, the project included detailed consideration of three decommissioning test cases: a Nuclear Power Plant (NPP) Test Case; a Research Reactor Test Case; and a Nuclear

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<sup>1</sup> The term “decommissioning plan” according to [6, para. 5.10] defines how the project will be managed, including: the site management plan, the roles and responsibilities of the organizations involved, safety and radiation protection measures, quality assurance, a waste management plan, documentation and record keeping requirements, a safety assessment and an environmental assessment and their criteria, surveillance measures during the implementation phase, physical protection measures as required, and any other requirements established by the regulatory body. The content of a decommissioning plan is presented in Appendix I of the main report.

Laboratory Test Case (Annex I of this report), as well as recommendations on the application of the graded approach to the development of decommissioning safety assessment (Annex II of this report).

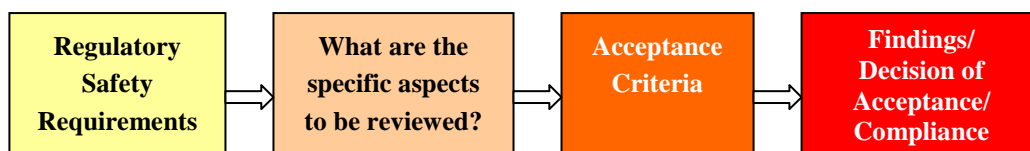
In addition to making recommendations on how operators involved in decommissioning activities need to prepare a safety assessment, the DeSa project also aimed to provide complementary recommendations for performing regulatory reviews<sup>2</sup> of the safety assessment. The present report (Annex III) is intended for use by the Regulatory Body in the performance of regulatory reviews, but it may also be helpful to facility operators during the development of a safety assessment.

Forming a judgment about the safety of decommissioning involves the assessment of the risks to health and safety of workers and to members of the public arising both from the conduct of decommissioning and from the presence of radioactive and hazardous materials within the facility to be decommissioned. The safety assessment and other information provided by the facility operator in support of an application for authorization must address these issues. The Regulatory Body must be able to conclude that:

- Appropriate safety principles have been applied and safety criteria have been met;
- Good engineering practice has been used in developing the decommissioning proposals; and
- Effective procedural controls will be applied during the decommissioning process.

The safety assessment and all supporting arguments must provide a high level of confidence that the decommissioning will be carried out safely and that the end-state of the facility after completion of decommissioning will meet all regulatory requirements.

From a regulatory perspective, the regulatory review of a safety assessment for decommissioning has a single overriding goal – in support of regulatory decision making, to provide a documented demonstration that the decommissioning activities can be carried out safely and meet regulatory requirements for protection of workers, members of the public and the environment (see Fig.1).



*FIG. 1. Steps of the regulatory review process.*

In all cases there will be three main aspects requiring review: (i) completeness; (ii) technical accuracy; and (iii) appropriate level of detail. This report provides specific recommendations for meeting these review goals.

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<sup>2</sup> The term “regulatory review” or “review” as used in this report refers to the review of the safety assessment by the Regulatory Body. The review of the safety assessment by the Regulatory Body may include approval of the assessment, if mandated by Member State legal framework.



The main challenges in developing recommendations for the regulatory review of safety assessment for decommissioning are:

- Integrating/coordinating the regulatory review of the decommissioning safety assessment within the wider review of the decommissioning plan;
- Applying an appropriate level of resources to the regulatory review of a safety assessment;
- Reviewing the acceptability (e.g. suitability and sufficiency) of engineered and procedural safety measures and the application of the defence in depth principle;
- Addressing the balance between consideration of radiological and non-radiological hazards and their evolution with time;
- Assessing the link between safety assessment results and proposed limits, controls and conditions; and
- Assessing compliance with regulatory requirements and criteria.

## 1.2. SCOPE

This annex addresses approaches and procedures for the regulatory review of a safety assessment for decommissioning of facilities using radioactive material. It covers decommissioning activities as authorized practices and provides recommendations on the links between safety assessment and other parts of the decommissioning plan.

It should be noted however, that the annex does not give recommendations on the regulatory review of other parts of the decommissioning plan that may be relevant to the safety assessment, other than to point out where such links exist.

The proposed regulatory review procedure is intended for use by regulators overseeing decommissioning activities. However, the procedure can be also considered a useful tool for reviews for other purposes such as:

- (a) Review by operators in order to gain confidence in the safety assessment results prior to submission to the Regulatory Body;
- (b) Review by an independent organization at the request of the operator; and
- (c) Review by an independent organization at the request of the Regulatory Body.

While this procedure is intended to be a tool for the regulatory review of a safety assessment for decommissioning, the Regulatory Body may wish to choose other appropriate mechanisms or tools to use in performing the review.

The regulatory review procedure comprises a set of questions to assist the reviewer through the systematic evaluation of the safety assessment, but cannot be considered as an exhaustive list of questions. The set of questions in this procedure can be expanded, reduced or condensed as considered appropriate by the Regulatory Body.

The recommendations in this annex have been developed for regulatory reviews of safety assessment supporting a final decommissioning plan and are focused on facilities for which immediate dismantling is proposed. Those facilities for which deferred dismantlement or entombment is proposed may require specific considerations in the application of the regulatory review procedure, appropriate to the type of facility to be decommissioned and the selected decommissioning strategy.

Non-radiological aspects and waste management (predisposal and disposal) facilities are beyond the scope of the report except insofar as they contribute to the radiological consequences.

### 1.3. OBJECTIVES

This Annex aims:

- (a) To recommend strategies and mechanisms for the regulatory review of a safety assessment for decommissioning;
- (b) To document a recommended procedure for the regulatory review of a safety assessment for decommissioning;
- (c) To promote the development of appropriate safety assessments for decommissioning by assisting operators in developing safety assessments through the provision of information on the approaches that will be used by Regulatory Bodies in evaluating their safety assessments;
- (d) To document the testing and illustration of these regulatory review procedures on the three DeSa test cases; and
- (e) To document the analysis of the results from the application of the regulatory review procedure to the three DeSa test cases for decommissioning of a nuclear power plant, a research reactor and a nuclear laboratory.

In addition, the annex aims to assist reviewers in determining whether the operators have adequately addressed issues related to safety of decommissioning, or directly affecting the decommissioning safety assessment, in particular:

- The identification and analysis of all relevant hazards and risks;
- The adequacy of prescribed safety limits, controls and conditions (including personal protective equipment) to protect the public, workers and the environment as established through the decommissioning safety assessment or other documentation within the decommissioning plan; and
- Verifying that the safety assessment has been prepared in a systematic and sound manner.

### 1.4. STRUCTURE

Section 2 of this Annex outlines the international safety requirements relevant to decommissioning of facilities. Section 3 discusses the link between safety assessment and the decommissioning plan, and the approach for review of common elements, such as facility description. Section 4 presents approaches and strategies for regulatory review of safety assessment for decommissioning based on international best practice. Section 5 describes a step-by-step approach for the regulatory review of a safety assessment for decommissioning and presents questions relevant to each step of the safety assessment. In Section 6 there is a brief discussion of some of the actions that might be taken by a Regulatory Body as a result of the regulatory review. Section 7 discusses outcomes based on experience from applying the review approach described in Section 5 to the three DeSa test cases. The Appendices provide example contents of a facility description in a decommissioning plan and examples of safety criteria used in safety assessment for decommissioning.

## **2. SAFETY REQUIREMENTS FOR SAFETY ASSESSMENT FOR DECOMMISSIONING**

International agreement on what is required to assure an acceptable level of safety during decommissioning of facilities using radioactive materials is reflected in the IAEA Safety Standards series and supporting documents. The safety requirements that are most closely related to this report include the Safety Fundamentals [9], the Safety Requirements on decommissioning [6] and the Safety Requirements on safety assessment [18]. Other applicable safety requirements are included the Safety Requirements for protection against ionizing radiation and for the safety of radiation sources [19], Safety Requirements for legal and governmental infrastructure [20], Safety Requirements on management system requirements [21], Safety Requirements on predisposal waste management [22, 23] and Safety Requirements for disposal of radioactive waste [24, 25].

These requirements documents are supported within the Safety Standards series by a variety of guidance documents. Among these guidance documents several [10-12, 26-33] contain recommendations relevant to safety assessment for decommissioning, and may be useful as references to help guide the preparation and review of a safety assessment for decommissioning.

The purpose of this section is to summarize those requirements directly applicable to the regulatory review of a safety assessment for decommissioning.

The operator has the primary responsibility for all aspects of safety and environmental protection during decommissioning activities. The operator's responsibilities include: establishing a decommissioning strategy, preparing and maintaining a decommissioning plan, establishing and implementing a management system, managing the decommissioning, identifying an acceptable disposal approach for all waste, performing safety and environmental impact assessments, preparing and implementing safety procedures, ensuring that properly trained, qualified and competent staff are available, performing radiological surveys, defining the end state, and complying with all regulatory requirements (including keeping records, preparing reports, notification, and obtaining approvals) as required by the Regulatory Body [6].

Of particular relevance to this report, the operator must perform an appropriate safety assessment [6] that provides confirmation that radiation doses or risks to individuals (workers and public) are optimized and kept below dose limits, that safety measures are appropriate, risks of incidents and accidents are reduced to be as low as practicable, and that due consideration is given to possible exposures of people both at present and in the future [18]. The extent and level of detail of the safety assessment should be commensurate with the complexity and the hazards associated with the facility and decommissioning operations, and should focus on the most safety-significant aspects.

The Regulatory Body is responsible for the establishment of safety standards and requirements and for carrying out activities to verify that these requirements are met. The Regulatory Body's responsibilities include: establishing criteria for facility shutdown, establishing safety and environmental criteria for decommissioning, establishing record-keeping requirements, establishing requirements for preparatory activities, reviewing and, if required, approving decommissioning plans prepared by the operator, giving interested parties an opportunity to comment on decommissioning plans, implementing inspection and review of decommissioning activities, establishing and evaluating

conditions on the end state of decommissioning and deciding whether final end state conditions have been met [6].

With respect to a safety assessment for decommissioning, when mandated by national requirements, the Regulatory Body's responsibility to review decommissioning plans includes the responsibility to verify that the safety assessment meets applicable regulatory requirements, as well as to verify that the safety assessment supplies adequate information to support the requirements for preparation for decommissioning. According to the degree to which safety assessment provides an important input to the safety management of decommissioning operations, the processes by which safety assessment is developed also need to be reviewed to provide confidence in the reliability of the safety assessment results.

Important requirements for decommissioning that require safety assessment as a support for demonstration of compliance are [6]:

- (a) Activities associated with the decommissioning of a facility shall be considered as part of the original practice [19];
- (b) Environmental protection, consistent with those of a practice, shall be maintained during the entire decommissioning process and beyond if a facility is released with radiological constraints;
- (c) Decommissioning activities do not impose undue burdens to future generations; and
- (d) Dismantling and decontamination techniques minimize waste generation and airborne contamination and ensure appropriate means for waste management from decommissioning.

Since the primary goal of the regulatory review of a safety assessment is to verify that the decommissioning plan and the decommissioning activities comply with safety and legal requirements, it is useful to provide a summary of these requirements here, based on the IAEA requirements document for safety assessment [18]:

- (a) Safety assessment shall be reviewed as part of the regulatory review of the decommissioning plan and also updated when significant unplanned changes occur, when there are significant changes in applicable knowledge and understanding, and when there are emergency safety issues (e.g. as a result of an accident) [6, 26];
- (b) The characteristics of the site relevant to safety shall be assessed, particularly those that affect the dispersion or migration of radioactive materials. The safety assessment shall identify the necessary physical barriers to confine radioactive material, as well as the need for supporting administrative controls.
- (c) The safety assessment is required to identify and assess the safety functions of systems (including procedural systems) and features (systems, structures and components - SSCs). Challenges to safety including vulnerabilities to failures and reductions in the reliability of achievement of safety goals during decommissioning shall be assessed along with any compensating measures (procedural as well as engineered).
- (d) The safety assessment shall demonstrate that engineered systems used are of robust and proven design, and that when innovative methods are used, their ability to meet safety requirements has been demonstrated. The safety assessment shall also identify where reliance is placed on procedural systems as a result of the dismantling of engineered systems, and demonstrate that these procedural systems provide an adequate level of safety.
- (e) Internal and external hazards (radiological and non-radiological) [10, 26] need to be addressed in the safety assessment.

- (f) The safety assessment shall take into consideration the effects of ageing of engineered systems at the facility, including implications for the qualification of equipment to meet accident or fault conditions that might be encountered during dismantling. The safety assessment shall also take into consideration feedback from experience, including both previous operational experience from the facility and experience gained from the decommissioning of other similar facilities.
- (g) The safety assessment shall identify input to the areas of personnel competences, training and staffing levels. It may also confirm that organizational and human factors have been taken into account in the design of teams, equipment and procedures.
- (h) In cases where the end-state includes on-site disposal of radioactive waste, or where the final end state does not meet criteria for unrestricted release, an assessment of the long-term anticipated and potential effects on human health and the environment shall be performed.
- (i) The safety analysis performed as part of the safety assessment shall address both “normal” conditions (i.e. proposed and anticipated evolution of the facility during dismantling) and accident conditions, including accidents that may occur as a consequence of events or failures during the performance of dismantling. The selection of scenarios to be analyzed and of events and processes to be considered shall be systematic, logical, structured and comprehensive. Uncertainties in the safety analysis shall be characterized. Data and computational methods shall be verified and validated.
- (j) A graded approach shall be used for determining the scope, extent and level of detail of the safety assessment. The degree of detail of the safety analysis shall depend on the level of hazard posed, the complexity of the facility and any inherent uncertainties. The safety analysis shall be documented with sufficient scope and detail to support the conclusions of the safety assessment.
- (k) Safety assessment shall be performed under the control of a safety management system [21]. The management system shall verify that input assumptions to the safety assessment are assured by safety management controls, that limits and conditions derived from the safety assessment are implemented, that suitable maintenance and inspection programmes are established, that adequate procedures are put in place (including operational and working procedures as well as on-site and off-site accident management and emergency response procedures), and that staff competences are defined and assured. The processes by which safety assessment is developed shall be planned, organized, applied, audited and reviewed in a way that is commensurate with the level of reliability to be placed on the results of the assessment. An independent review of the safety assessment shall be performed.
- (l) Safety assessment shall be used to support management decisions in an integrated risk informed approach.

The level of regulatory review should be adequate to verify that the safety assessment meets the relevant safety requirements. In accordance with the fundamental safety principle the requirements for protection and safety are to be applied in a manner commensurate with the level of risks [8, 26], a graded approach is to be applied not only to the preparation of safety assessment, but also to the review. The application of this graded (or safety-focused) approach to regulatory review is described in detail later in Section 4.4.

### 3. REGULATORY REVIEW OF SAFETY ASSESSMENT

The regulatory review of a safety assessment is an integral part of the evaluation of the overall decommissioning plan. A regulatory review of a decommissioning safety assessment will normally follow four steps (see Fig. 2):

- (a) An inception step prior to receipt of any documents in which initial planning for the review will be conducted. This review will normally involve meetings between the operator to understand the extent of the information that will be provided; to agree upon the objectives of the safety assessment; to develop a time table for submission of documents and for completion of the regulatory review, and to inform the operator about the regulatory process that will be used to review the safety assessment.
- (b) An initial review step during which the Regulatory Body will make a preliminary evaluation of the submitted documents to assess completeness and the availability of supporting documents. This initial regulatory review enables identification of those issues that are most important to safety. This, together with the first step, allows the review to be scoped and planned (e.g. identification of an appropriate review team) to ensure it will meet the defined objectives and any declared timeframes.
- (c) A main technical review step during which the fault assessments are reviewed in detail and preliminary comments and conclusions are identified and documented. These comments and conclusions need to be fed back to the operator in a timely manner to allow, where possible, approaches to be identified to resolve outstanding regulatory concerns and give the operator an opportunity to respond and where necessary, make changes.
- (d) A completion step during which a final set of comments and conclusions outstanding from the technical review step are identified. The Regulatory Body needs to set out these comments and conclusions in a document along with recommendations for regulatory action (e.g. approval or rejection of the decommissioning proposal) and any regulatory conditions and limits which need to be applied by the operator in the light of outstanding regulatory concerns (e.g. hold points, operation sequences).

The timing, depth and scope of these four steps need to be tailored to the safety assessment. For example, in cases where decommissioning is conducted in stages, the regulatory reviews also need to be performed in a corresponding stepwise fashion. Similarly the review needs to be organized in a manner that ensures regulatory decisions are made in a timely manner following submission of the documentation.

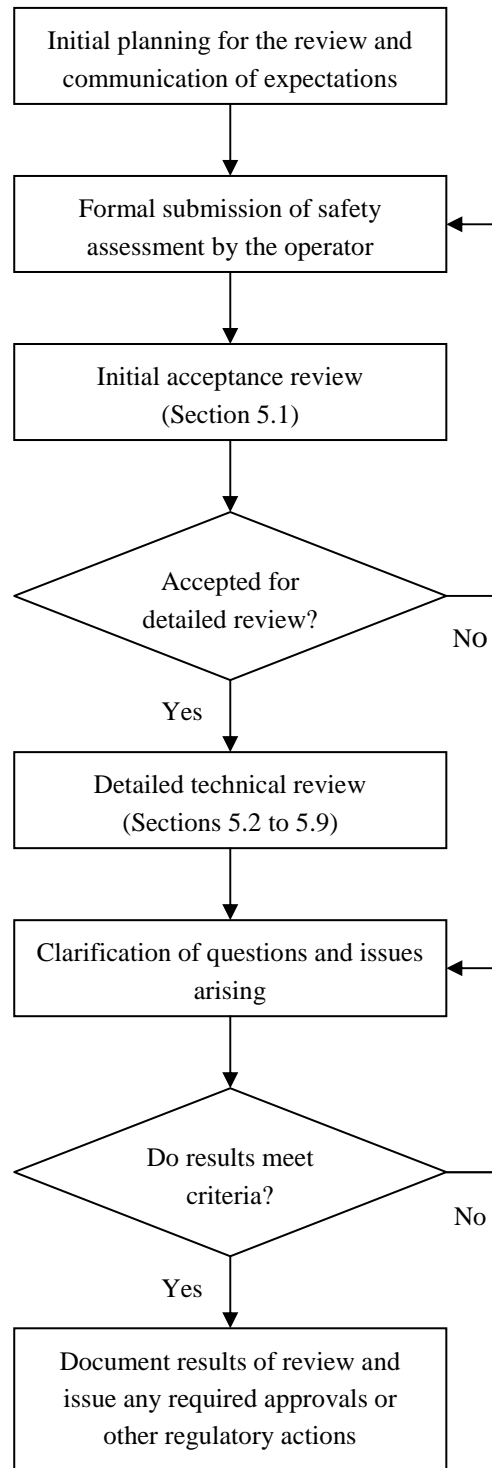


FIG. 2. Main steps of the regulatory review process.

Guidance on the contents of a decommissioning plan can be found in several publications [10-12, 15, 26]. Appendix I to the main report contains a suggested comprehensive table of contents for a decommissioning plan, based on the references cited above. Applying a graded (safety-focused) approach, some of the elements of this list may not be required for smaller, less complex or less hazardous decommissioning activities provided this still meets all requirements set out by the Regulatory Body and is consistent with the actual situation.

Since the act of decommissioning changes facilities, it is important to recognize that safety assessment for decommissioning may need to change with the evolving state of the facility. As a result, regulatory reviews of decommissioning plans which in other nuclear safety-related contexts would normally be carried out on a time-wise basis are more likely to be event-driven (i.e. take place as predefined key points in the decommissioning are reached). These key points need to be identified explicitly and appropriate review points specified. The frequency and extent of these regulatory reviews will vary from facility to facility. For example, many review points might be expected over the lifetime (including decommissioning) of a complex, high hazard facility, whereas for a simple facility as few as two (at the start of decommissioning and at completion of work with radioactive material) might be all that is required. Such staged reviews may be linked to the appropriate authorization process where this is considered necessary.

The decommissioning plan can also include procedures (approved by the Regulatory Body) for implementing changes in the plan. This is an efficient way to allow the operator to proceed with the decommissioning without requiring unnecessary regulatory oversight of every individual change. However, for changes relevant and important for safety the consent or approval of the Regulatory Body is necessary if and when mandated by national requirements.

It is essential that the safety assessment is consistent with:

- (a) The decommissioning strategy, activities, assumptions, timeframes, etc.;
- (b) Waste management strategies, waste acceptance criteria, etc.; and
- (c) Starting and endpoint of the decommissioning, etc.

Several elements of the decommissioning plan are directly relevant to the safety assessment. These items do not need to be reproduced in the safety assessment, but can be referred to the decommissioning plan, as long as they contain adequate type and quality of information to support the safety assessment.

Examples for such common elements include:

- (a) The facility description: e.g. the site location and description, buildings and systems, radiological status, facility operating history;
- (b) Regulatory requirements: e.g. legal and regulatory framework; radiological criteria; clearance criteria for materials; site release criteria;
- (c) Decommissioning activities and schedules: e.g. contaminated structures, systems and equipment, soil and groundwater; decommissioning approach; stages and work packages, continuing operations at the site, if any;
- (d) Availability of special services, engineering and decommissioning techniques;
- (e) Available safety assessments;



- (f) Waste management: e.g. planning for waste streams (sources, volume, locations, etc.) and waste management practices;
- (g) Quality management programmes; and
- (h) Supporting activities: e.g. surveillance and maintenance, compliance and environmental monitoring, health and safety, staff training, and emergency planning [18, 26].

The balance between doses to workers and radiological risks to members of the public can be an important issue in decommissioning where the measures necessary to protect the public from potential unlikely acute (accident) doses may result in practices that expose workers to low level, long term doses, (e.g. from working in highly contaminated environments where the only reasonable way to offset risks to the public is to carry out decommissioning activities manually). Regulatory Bodies will need to be satisfied that operators have made such risk balances prudently based on a suitable and sufficient safety assessment that evaluate the risks to all groups in comparable terms.

On the basis of the safety assessment the Regulatory Body needs to decide on whether the operator is minimizing risks, balancing different types of risk and can justify the risks arising from decommissioning in terms of the longer-term hazard removal to an appropriate degree. It is often the case, particularly in large, complex decommissioning activities, that the predicted risks will exceed normally permitted levels, albeit only for short periods. Where this is the case, the safety assessment needs to be treated with caution by the Regulatory Bodies who will seek inherently safer options, early removal of the hazard and a cautious approach to any uncertainties. These aspects are usually more important than numeric considerations such as cost benefit analysis and probabilistic risk assessments.

In addition, the preparation of the safety assessment will likely utilize common organizational processes (e.g. project management, quality management) shared with the wider decommissioning activities. It is sensible therefore to review these common elements and processes alongside the safety assessment.

Overall, the safety assessment provided in support of the decommissioning plan needs to be well constructed and properly linked to the plan. As the safety assessment needs to be consistent with the decommissioning plan, the plan and its supporting safety assessment need to be developed in an integrated and iterative manner. Similarly, Regulatory Bodies need to carry out their review activities recognizing these links and making judgements in regard to which parts of the recommendations are applicable to their situation and the extent, within an overall graded approach, this needs to be applied.

#### **4. REGULATORY REVIEW STRATEGIES AND APPROACHES**

Regulatory reviews of a decommissioning plan and the supporting safety assessment are conducted to assist the Regulator Body's decision-making on the safety of decommissioning activities or other activities where decommissioning impacts on safety. Regulatory reviews focus on determining whether the safety assessment demonstrates that the decommissioning plan and the proposed decommissioning activities comply with regulatory safety requirements and criteria.

An appropriate safety assessment has to demonstrate safety during decommissioning. In order to perform such assessment:

- The input assumptions need to be valid;

- The assessment needs to reflect the actual activities and state of the facility; and
- The safety assessment needs to reflect the evolution of the facility as decommissioning proceeds and as knowledge and understanding improve.

#### 4.1. OBJECTIVES OF REGULATORY REVIEW

The main objective of the regulatory review of a safety assessment for decommissioning is to determine if the assessment has been conducted and reported in an acceptable manner (e.g. quality, level of detail) and whether it is fit-for-purpose. Any judgment as to whether a particular safety assessment is fit-for-purpose has to take account of the nature of the facility being (or to be) decommissioned, the decommissioning strategy and the associated assessment context (i.e. the phase in the facility lifetime which the safety assessment is supporting).

The specific objectives of the regulatory review therefore are to:

- (a) Provide a suitable documented basis upon which Regulatory Bodies can agree to, or reject, the operator's application to carry out the proposed decommissioning activities;
- (b) Determine the extent to which the operator's safety assessment demonstrates that decommissioning activities will comply with all relevant regulatory requirements, criteria, policy and guidance;
- (c) Identify any authorization limits, controls and conditions that will need to be applied before, during and after (where appropriate) decommissioning activities;
- (d) Provide information relevant to the wider regulatory review of the decommissioning plan and to other reviews of safety assessment in support of later stages of the plan; and
- (e) Provide confidence that regulatory decisions related to decommissioning have been taken in an appropriate manner.

The reviewer needs to check that the safety assessment clearly describes the potential sources of hazards, the potential consequences of exposure, the protection measures and monitoring and control measures that are in place, and any measures that are in place to limit the consequences of release of hazardous materials or exposure to hazards.

#### 4.2. SCOPE OF REGULATORY REVIEW

The objectives and scope of the regulatory review need to be clearly defined at the outset, and then refined as necessary during this review. Since the primary objective of the regulatory review will normally be to evaluate compliance of the safety assessment with applicable regulatory requirements as an aid to later decision-making, the scope of the review needs to reflect all relevant regulatory safety requirements and criteria, as well as the scope of the safety assessment being reviewed. The type of regulatory decision to be made needs also to be taken into account when defining the objectives and scope of the review.

The scope of the regulatory review of the safety assessment for decommissioning can be different, for example:

- Safety assessment for a specific stage of the decommissioning or for all stages;
- Safety assessment for specific systems, structures and components within a facility, for a specific facility within a multi-facility site, or for an entire site;

- Safety assessment update during decommissioning or also after completion to demonstrate compliance with site release criteria; and
- Review of specific parts of the safety assessment such as review of modelling or of scenarios, etc.

When the objective of the Regulatory Body is to review the overall decommissioning activities based on a multi-staged implementation of long duration, it may be decided that a detailed regulatory review of the safety assessment need to be performed only for the first stages e.g. from 5 to 10 years. A less detailed regulatory review of the following decommissioning stages may focus instead on the review of technical feasibility and associated safety principles. For these later stages a detailed regulatory review would be performed later, based on updated safety assessment(s).

In order to achieve the objectives of the regulatory review, the scope of the regulatory review of the safety assessment for decommissioning needs to consider the following:

- (a) Whether the decommissioning activities are adequately described. This is especially important in staged decommissioning activities where the safety assessment needs to be updated to reflect the current status of the facility and in situations where the facility or systems being decommissioned are part of a larger facility or multi-facility site. In particular, for staged decommissioning, the appropriateness of the proposed stage endpoints needs to be reviewed. In order to achieve this, the regulatory review of the safety assessment needs to be coordinated with the review of the decommissioning plan (see Section 3). The regulatory review also needs to consider interactions between the safety assessment being received and other relevant safety assessments, e.g. for other facilities on a multi-facility site whose safety is affected by the decommissioning activities.
- (b) Whether the safety assessment adequately describes and takes into account all relevant requirements and criteria of the regulatory framework and of the Regulatory Body.
- (c) Whether the safety assessment provides adequate coverage of all relevant safety issues. In particular the hazard analysis reported within the safety assessment needs to consider:
  - Normal and accident conditions;
  - Consequences to workers, the public and to the environment; and
  - Radiological and non-radiological hazards (e.g. industrial hazards, toxic and other dangerous chemicals, etc.)
- (d) Whether hazards have been considered for their combined and additive affects and in particular, the extent to which non-radiological hazards might lead to radiological consequences (e.g. fire leading to loss of containment). Further, the safety assessment needs to demonstrate that an overall risk optimization process addressing radiological and non-radiological risks has been undertaken appropriately.
- (e) Whether the quality and depth of analysis applied in the safety assessment, and in particular the hazard analysis identification, screening and evaluation is valid, up-to-date, fit for purpose and commensurate with the safety significance of the proposals, taking due regard for uncertainties.
- (f) Whether the procedural and engineering limits, controls and conditions proposed within the safety assessment, and in particular any limits or conditions or engineering standards identified will be suitable and sufficient to reduce risks and/or consequences to workers, public and the environment to an acceptable level.

#### 4.3. OUTCOMES OF REGULATORY REVIEW

The outcomes of the regulatory review of the safety assessment need to be documented in a manner which:

- (a) States whether or not there is compliance with relevant safety requirements and criteria;
- (b) Lists any actions that may be required by the Regulatory Body as a result of the review;
- (c) Provides a transparent and auditable account of:
  - How the regulatory review was conducted;
  - What safety standards, criteria, policies and guidance were applied;
  - How the identified objectives of the regulatory review were addressed.
- (d) Lists final comments and conclusions arising from the regulatory review process, their basis and how these will be resolved;
- (e) Makes recommendation(s) for regulatory action and decision-making (e.g. to agree or reject activities supported by the safety assessment) and identify any authorization limits or conditions that need to be applied to the regulatory decision; and
- (f) Demonstrates that the regulatory review has been undertaken in an informed, independent and accountable manner by suitably qualified and experienced personnel.

Findings from a regulatory review of safety assessment will normally make a significant contribution to regulatory decisions on whether or not to proceed with the next step in the authorization or licensing process for decommissioning. In addition these reviews will often provide the primary means for determining appropriate authorization limits, controls and conditions that the Regulatory Body may elect to put in place as part of its authorization of the operator's proposed activities.

#### 4.4. FOCUS OF APPLICATION OF REGULATORY REVIEW ON ISSUES OF SAFETY SIGNIFICANCE

The regulatory review of the safety assessment should focus on safety issues relevant to decommissioning. This graded approach is appropriate in order to:

- Allocate of human and financial resources proportionate to the hazard potential or risk (both taking due regard for uncertainties); and
- Focus on areas of safety concern to regulators or to other interested parties (e.g. a physical area of a facility, a technical discipline or a particular aspect of the proposals) receive the greatest scrutiny.

Overall, regulators have to aim at maximizing the benefit of (usually finite) available resources. Also, the Regulatory Body needs to establish procedures that make it clear to operators, interested parties and the public how the Regulatory Body grades its actions according to the safety significance of the operator's proposed decommissioning work and the associated safety assessment.

Consequently, in adopting a graded (safety-focused) approach, Regulatory Bodies always need to ensure that the depth and extent of regulatory review of safety assessment are suitable and sufficient so that proposals for decommissioning are given an appropriate degree of regulatory scrutiny. Similar considerations apply to Regulatory Bodies issuing formal approvals and licences. If necessary

Regulatory Bodies need to extend the schedules for these reviews (recognizing that this will impose delays on operators), or seek additional resources, so that appropriate standards are always maintained.

Adoption of a graded approach to the regulatory review is likely to necessitate decisions on the following aspects:

- (a) The extent of review activities, i.e. which parts of the safety assessment will be reviewed? In general the regulatory review needs to focus on those aspects of greatest regulatory safety concern.
- (b) The depth of the review, i.e. what type of review activities will be undertaken (e.g. approximate first-order confirmatory calculations; random/systematic consistency checks; full repeat calculations (possibly double-blind); diverse calculations; limited assumption checks, etc.)? Here the strategy needs to be flexible enough to allow a more detailed approach to be followed in individual areas as considered necessary.
- (c) The extent to which specific checks of the safety assessment may be deferred in favour of generic checks, reviews and inspections of the operator's wider processes and systems relevant to the decommissioning activity (e.g. management system, training, radiation protection, etc.).
- (d) How any shortcomings during the sampling process will be addressed (e.g. the need for further sampling).

In applying the graded approach described in this report, variations in the degree of regulatory attention can be applied to safety assessment for decommissioning by using different approaches, e.g.:

- (a) The Regulatory Body and the operator would establish a dialogue to agree on the safety relevant documentation of the safety assessment to demonstrate that the decommissioning can be conducted safely. That information needs to be submitted to the Regulatory Body.
- (b) The Regulatory Body, on the basis of the documentation submitted according to the national safety requirements and criteria, will review the information applying expert judgement. This judgement will extend to the emphasis of the review and focusing it to the safety relevant aspects.
- (c) The Regulatory Body may also establish categorization schemes for facilities or safety assessments for which the necessary level of documentation is a priori defined.

Regardless of the approach selected for a regulatory review, the approach adopted for this review needs to take the following considerations into account:

- Where the facility is within its lifecycle.
- The proposed end-state of the facility following completion of the decommissioning activities addressed within the safety assessment. For example, the regulatory review of a safety assessment leading to site release for unrestricted use may demand a greater degree of scrutiny than an assessment in support of a single stage in the middle of a larger decommissioning activity.
- Safety requirements and criteria deriving from national policies, regulations, guidance or criteria.
- The complexity of the decommissioning activities and the potential for unforeseen circumstances to increase the level of risk;
- The extent to which the decommissioning activities will utilise proven practices and techniques, or whether a novel approach (with consequent uncertainties) is to be followed.

- The ease of implementing any limits, controls and conditions identified as a result of the safety assessment.
- The scope of the operator's safety assessment. For example, in a multi-stage decommissioning, Regulatory Bodies need to target their attention to those stages posing the greatest impact on safety.
- The quality and level of detail of the operator's safety assessment. Here, adoption of a graded approach leads to decisions with regard to the degree with which the reviewers will sample the operator's safety assessment. In cases where the operator has prepared what appears to be a high-quality and comprehensive assessment, a limited (but still appropriate) sampling approach may be appropriate. Conversely, if the safety assessment is short and/or superficial, a more detailed regulatory review may be warranted.
- The degree of uncertainty in the basic data and assumptions that the safety assessment is based on.
- Predicted radioactive releases and worker doses arising from proposed decommissioning activities.
- The potential for decommissioning activities to lead to unauthorized and/or uncontrolled releases of radioactivity, either through proposed activities or following an accident. In particular the consequences of individual scenarios to the public and to workers and the associated risks from these scenarios need to be considered, taking due allowance for uncertainties.
- Political and other interested party concerns. The graded approach needs to ensure that the regulatory activities are undertaken in an appropriately transparent and accountable manner.
- The operator's relevant experience in undertaking similar decommissioning activities. Equally, if the operator is relying significantly on contractors to perform the decommissioning, their track record and/or relevant experience needs to be considered, as well as the operator's degree of supervision of contractors.
- The Regulatory Body's confidence in the operator's (or its contractor's) ability to prepare a suitable and adequate safety assessment.
- Use of good practice, including engineering standards and maintenance, inspection and testing programmes.
- The resources, including personnel, being applied by the operator.
- International standards and guidance, as well as good practice.

Overall the approach to regulatory review needs to be suitable and sufficient to ensure that, at the end of the review process, the Regulatory Body will have an appropriate level of confidence in the operator's safety assessment commensurate with the risks and hazards posed by the proposed decommissioning activities and meeting the stated scope and objectives of its review.

#### 4.5. REGULATORY REVIEW ENGAGEMENT PROCESS

The graded approach outlined in the previous section needs to be applied primarily through a regulatory review of the written safety assessment submitted by the operator. As such, the operator needs to verify the adequacy of its safety assessment, following a pre-defined written internal procedure, prior to submitting the safety assessment to the Regulatory Body.

In addition to reviewing the safety assessment, the regulatory review may need to be supplemented by meetings, facility inspections, process audits and information gathering visits, as necessary, in order to:

- (a) Clarify any areas of uncertainty (technical or procedural);
- (b) Provide a means by which the Regulatory Body can be confident that the safety assessment has been conducted to a quality, level and depth commensurate with the safety significance of the decommissioning activities and reflects the current condition of the facility;
- (c) Engage with the operator regarding the overall strategy for decommissioning activities that are part of a larger decommissioning programme; and
- (d) Review other parts of the decommissioning plan which support the safety assessment.

These activities, along with the regulatory review itself, need to be conducted by the Regulatory Body, or by representatives appointed by the Regulatory Body (provided this is permitted by relevant national legislation). Operators may also employ external technical specialists, consultants or contractors to develop the safety assessment. However, where meetings, audits and visits carried out as part of, or in support of, the regulatory review involve interactions with persons employed by the operator, these meetings, audits and visits need to be conducted in such a manner that the operator is aware of and retains responsibility for all information provided on its behalf. A representative of the operator needs to be present at all meetings between the Regulatory Body and developers/technical experts held as part of the regulatory review of the safety assessment. Regardless of the degree to which contractors are used, the ultimate responsibility for preparing the safety assessment rests with the operator, and the ultimate responsibility for performing the review rests with the Regulatory Body.

#### 4.6. MANAGEMENT OF THE REGULATORY REVIEW PROCESS

The regulatory review of the safety assessment needs to be undertaken in a structured and systematic fashion in accordance with the Regulatory Body's own written quality and project management procedures. These procedures need to be suitably detailed and fit-for-purpose. The procedures must instill confidence that the regulatory review will provide an appropriately informed, transparent and independent basis for consistent and accountable regulatory decision-making in accordance with all relevant legislation and criteria. Regulatory review procedures must also ensure that the review process will be performed within an appropriate timeframe.

The Regulatory Body's procedures also need to be suitably flexible to allow the regulatory review to be undertaken either as a standalone project or as part of a wider project (e.g. within a review of the decommissioning plan or as part of a larger licensing project) depending on the extent and nature of the decommissioning proposals and the safety assessment under consideration. Similarly, the regulatory review procedures need to adopt a graded approach in line with the principles set out in Section 4.2 above. If the regulatory review is to be conducted using the services of contractor organizations, the project and quality management arrangements (including the contracting organization's own internal arrangements) need to be suitable to ensure the work is adequately managed with the Regulatory Body retaining ultimate responsibility for the quality and outputs of the regulatory review.

The Regulatory Body's management of its decommissioning safety assessment review process needs to address the following:

- (a) The identification of all relevant safety requirements, acceptance criteria, and guidance to be applied. In the interests of regulatory consistency, this needs to include, where relevant,

identification of similar cases to that being considered where, for example, interpretation of these aspects was not straightforward.

- (b) Definition of the scope and the required outputs from the regulatory review (see Sections 4.2 and 4.3) based on the form of graded approach to be adopted (see Section 4.4). Where necessary, the scope needs to set out the relation with other areas (e.g. other review topics within the wider decommissioning plan).
- (c) Planning of the review process addressing the four steps of the regulatory review set out in the previous section. Particular consideration needs to be given to:
  - The context of the regulatory review within the overall authorization process of the decommissioning plan;
  - Dependencies on, and the safety requirements of, other competent authorities;
  - The need to integrate the results of, and ensure good lines of communication between individual review activities, especially if this involves contributions from external organizations or other authorities;
  - Project risks, particularly taking into account the degree to which the operator's proposals are vulnerable to technical uncertainties or utilise novel techniques;
  - Defining appropriate internal review steps (e.g. in accordance with the Regulatory Body's management system);
  - The availability of the required resources (e.g. financial, technical and administrative personnel). If necessary, the review plan needs to make provision for staff training to ensure those conducting the regulatory review are suitably qualified and experienced;
  - Communications with the operator. Here the operator needs to be engaged to an extent that ensures the regulatory review is undertaken in an appropriately informed, timely and cost effective manner. However, the level of engagement must not compromise the Regulatory Body's independence, nor the operator's full responsibility for safety during the proposed decommissioning or other activities (see Section 4.3); and
  - The timing of quality assurance activities (e.g. verification, peer reviews, acceptance reviews, etc.). In particular, the quality assurance programme needs to include an experience feedback process to capture any "lessons learned" for use in future regulatory review projects.
  - The development and approval of final conclusions and recommendations.

The planning of the regulatory review process needs to result in the preparation of a review programme (or schedule), based on the availability of resources, the proposed (or specified) dates for the delivery of the operator's safety assessment documentation and when a regulatory decision is required. The programme needs to identify and allocate responsibility for individual activities within the review process, provide a timetable for delivery of these activities and where necessary needs to specify the regulatory review procedures to be used and the required competences of the reviewers. The programme needs to be provided in a form and to a level of detail commensurate with the management needs of the reviewing organization(s). It should address the following subjects:



- (a) Provision of (and where necessary development of) suitable written instructions to ensure the safety assessment review is undertaken to an appropriate level of quality and in an efficient manner. Aspects to be considered here include the need for:
- Performance of the review according to its programme, its scope and goals;
  - Application of the graded approach to be followed;
  - Completeness and adequacy of coverage of the instructions;
  - Adequate internal processes for development, update and review the instructions;
  - Adequate internal processes for detection and remedy of any failures to achieve an appropriate level of quality;
  - The Regulatory Body’s “ownership” of the regulatory review. This may necessitate the need for procedures to govern the acceptance of review outputs on behalf of the organization;
  - Regulatory consistency (e.g. with previous similar cases), transparency and accountability; and
  - Collection and preservation of relevant experiences and “lessons learned”.
- (b) Setting up the review team. This needs to comprise of individuals and organizations who the Regulatory Body considers to be suitably competent, qualified and experienced to undertake such a review to an appropriate standard. If permitted within national legislation, the regulatory review may be conducted under contract by an external organization. However, where this is the case, the results of the regulatory review will nevertheless remain fully “owned” by the Regulatory Body, which will retain responsibility for the review’s quality, its outcomes and all subsequent regulatory decisions based upon it. Where external organizations or other contractors are employed, these need to be independent of the operator.
- (c) Management of the operator-regulatory engagement process described in Section 4.3. Here consideration needs to be given to:
- The planning of hold points, decision points and other key stages within the review process where the operators will need to be engaged;
  - Protocols for meetings, audits, visits, inspections, etc.;
  - Protocols for obtaining the safety assessment and other related documentation from the operators; and
  - The extent to which the operator will be advised in regard to comments and recommendations arising from the review process.

## **5. REGULATORY REVIEW PROCEDURE**

The safety assessment generally is part of the decommissioning plan or developed in support of this plan. Therefore the team responsible for the safety assessment review might also be involved in the decommissioning plan review. Nevertheless, as mentioned before in Section 3, some information in the decommissioning plan is relevant for the safety assessment review. It therefore is an important task in the preparation of the safety assessment review process (and as a task within the first step of the

regulatory review engagement process) to verify the appropriateness of the information common for the assessment and the decommissioning plan. The regulatory review needs to verify that there is sufficient information to support the input assumptions to the safety assessment. The sources of information need to be clearly identified within the safety assessment, along with evidence in support of their reliability and consistency.

The following sections do not address all the items that could be found within the decommissioning plan, e.g. site description (see Appendix I), but focuses on those that are particularly relevant to safety and thus on which the regulatory review needs to focus taking into account the level of detail commensurate with the complexity of the facility (graded approach).

The following sections provide some key questions which may help to perform the regulatory review in a structured and systematic way and which may be part of the questions which are asked during the regulatory review of the decommissioning plan. The lists of questions are not considered to be exhaustive or comprehensive; rather, they should be regarded as suggestions to help reviewers focus on aspects of importance to be reviewed. Moreover, not all questions will be relevant in every case. However, these questions may provide prompts for further questions relevant to the safety assessment being reviewed. The intent of the questions is not to provide an exhaustive checklist (such that satisfactory answers to all questions might be considered to guarantee safety); rather, they should be considered as recommendations provided to help reach a conclusion on whether the safety assessment is adequate.

### 5.1. GENERAL ISSUES FOR INITIAL REGULATORY REVIEW

During the inception step and the initial review step of the regulatory review engagement process (see Section 4.5) it is advisable to first perform a high level review based on more generic review issues. This review should help the Regulatory Body:

- (a) To make a preliminary confirmation that the safety assessment is consistent with the current version of the decommissioning plan;
- (b) To make a preliminary confirmation that the list of identified hazards appears to be complete; and
- (c) To make a preliminary confirmation that the results of the safety assessment appear to be realistic.

If the results of this initial review are not satisfactory, the Regulatory Body needs to communicate information on the deficiencies to the operator in order to permit the operator to revise the safety assessment to address and resolve those deficiencies. If the results are considered satisfactory, the Regulatory Body will proceed with the next more detailed step of review.

The following questions address aspects that are important for a systematic evaluation of information during the initial review:

- (a) Are the decommissioning activities assumed within the safety assessment consistent with the descriptions and assumptions in the current version of the decommissioning plan?
  - Are the scope and context of the safety assessment consistent with the rest of the decommissioning plan?
  - Are the decommissioning and dismantling activities referred to in the safety assessment consistent with the rest of the decommissioning plan?

- Are the decontamination and dismantling techniques referred to in the safety assessment consistent with those of the rest of the decommissioning plan?
  - Do the predicted normal operation doses/risks appear to be reasonable given the proposed decommissioning activities?
  - Do the predicted normal operation doses/risks comply with regulatory limits and criteria?
  - In case of a multi-stage decommissioning, is the endpoint of the previous decommissioning stage consistent with the facility state prior to decommissioning assumed in the decommissioning plan?
- (b) Is there sufficient evidence that the results of the safety assessment are likely to be reliable?
- Are all supporting documents used in the safety assessment clearly referred to and uniquely identified?
  - Is the safety assessment itself documented such that it can be referred to later?
  - Was a safety management system applied during the development of the safety assessment?
  - Do the scope, extent and level of detail of safety assessment correspond to the types of hazards and their potential consequences?
  - Are the objectives of the safety assessment presented? Do the assessment outputs correspond to the assessment objectives?
  - Are the results of the safety assessment in compliance with the requirements and criteria?
  - Are the proposed safety measures (limits, controls and conditions) adequate?
- (c) Does the safety assessment include a systematic evaluation of the nature, magnitude and likelihood of consequences to workers, public or the environment during proposed decommissioning activities and in accident conditions?
- (d) Is there evidence that the list of identified hazards and initiating events is likely to be complete? Are there obvious gaps?
- Does the safety assessment provide or reference adequate descriptions of:
    - (i) The site and immediate environment sufficiently to give a good understanding of the nature and extent of contamination at the site;
    - (ii) The safety requirements and criteria for the site, e.g. the relevant dose limits and constraints;
    - (iii) A summary of the ALARA (As Low As Reasonably Achievable) evaluations;
    - (iv) A summary of institutional controls (where relevant)?

- Is the safety assessment understandable for review?
  - (i) Is the presentation in a form that fits the Regulatory Body’s expectations to be able to review all aspects regarded as relevant?
  - (ii) Is the level of detail in line with the Regulatory Body’s expectations to allow a clear understanding and review of the safety assessment?
  - (iii) Can the results be compared with relevant limits and criteria?

## 5.2. REGULATORY REVIEW OF THE ASSESSMENT FRAMEWORK

The objective of the description of the assessment framework is to summarize all the regulatory conditions, safety requirements and criteria taken into account during the safety assessment. It documents the aspects of the decommissioning activities that are subject to the safety assessment and explains the safety assessment methodology applied. In addition, it explains the types of output which are produced within the safety assessment.

Accordingly, the regulatory review needs to verify that all these aspects are in line with requirements for a safety assessment, to demonstrate that safety is ensured during the proposed decommissioning activities.

Following the general DeSa safety assessment methodology in Section 3.1 of the main report, in the following sections, questions and recommendations are provided to support the review of the assessment framework.

### 5.2.1. Context of safety assessment

The safety assessment should reflect the decommissioning activities described in the decommissioning plan. The reviewer should determine whether the assumptions and statements within the safety assessment are consistent with:

- (a) The scope and objectives of the decommissioning plan as a whole, both in its extent and its timeframes?
- (b) The description of the facility?
- (c) The proposed decommissioning activities and related waste management activities?
- (d) The waste management plans?

The regulatory review needs also to check whether the safety assessment provides sufficient information on:

- What is evaluated (the safety related activities)?
- Why activities are evaluated, and at what level of detail?
- How was safety for decommissioning evaluated (what approaches or methods are implemented)?

The reviewer needs also to find answers to the following questions:

- (a) Is the assessment an iteration of a previous safety assessment? If so, was the previous iteration reviewed and what were the conclusions of that review?
- (b) Is the assessment similar to other safety assessments? If so, were these similar assessments reviewed and what were the conclusions of those reviews?
- (c) Are the supporting systems and facilities referred to in the safety assessment consistent with those of the latest version of the related decommissioning plan? In particular, are the measures for quality assurance (typically as part of the safety management system) referred to in the safety assessment consistently?

### **5.2.2. Scope of the safety assessment**

The reviewer needs to confirm that the scope of the safety assessment covers all relevant safety related activities set out in the decommissioning plan. The following questions help support a systematic analysis of safety assessment:

- (a) Is the scope clear and unambiguous? In particular, is it clear whether the safety assessment is supporting the overall decommissioning or a decommissioning stage?
- (b) In the case of a multi-stage decommissioning, are the interfaces between the related safety assessments clearly stated and has a consistent approach been adopted?
- (c) Are material management measures taken into account in the safety analysis? If not, is a justification provided?
- (d) If neighbouring systems or components or facilities exist that are not subject to the current decommissioning activities, is there a clear statement whether there are safety relevant interfaces that need to be considered? If so are they clearly identified? If not, is there a safety related justification provided?
- (e) Are all relevant interfaces clearly defined – e.g. between neighbouring facilities, common systems, waste management activities?
- (f) If some significant activities or parts of the site/facility are not included within the scope of the assessment, is justification for this provided in the assessment?

### **5.2.3. Objectives of the safety assessment**

The main objective of the safety assessment is to demonstrate the safety of the proposed decommissioning activities (i.e. to provide a documented demonstration that the decommissioning activities can be carried out safely and meet regulatory requirements for protection of the workers, members of the public and the environment [27]) to the operator, to the Regulatory Body and to interested parties. The following questions may help to identify whether the provided safety assessment has clear objectives:

- (a) Has the primary purpose(s) of the safety assessment been identified?
- (b) Is there evidence that the safety assessment is performed to demonstrate safety?
- (c) Does the safety assessment address the following:
  - Document how regulatory requirements and criteria are met to support authorization of the proposed decommissioning activities?

- Include a systematic evaluation of the nature, magnitude and likelihood of hazards and their consequences to workers, public and the environment during proposed activities and during accident conditions?
- Quantify the systematic and progressive reduction in radiological hazards to be achieved through implementation of the decommissioning activities?
- Identify the safety measures, limits, controls and conditions that will need to be applied to the decommissioning activities to ensure that the relevant safety standards are met and maintained throughout the decommissioning?
- Provide input to on- and off-site emergency planning and to safety management arrangements?
- Provide an input to the identification of competency requirements for staff performing decommissioning activities and of training needs for decommissioning?

#### **5.2.4. Timeframes**

Timeframes are often a crucial aspect of decommissioning, especially when these decommissioning activities can last decades. The reviewer needs to confirm that the safety assessment is based on a detailed timeframe (schedule) consistent with that set out in the overall decommissioning plan, and that consequences are taken into account, including the timing of all individual stages (where relevant) and any timeframes for ongoing institutional controls (i.e. continuing land restrictions).

The following questions may support such a review:

- (a) Are the timeframes clearly defined?
- (b) What timeframes have been considered in the safety assessment, and what is the rationale for selection of these timeframes?
- (c) Are the timeframes justifiable from a safety perspective (e.g. balancing increasing risks from ageing structures with dose benefits from radioactive decay) taking into account not only the timeframe related to the safety assessment but all timeframes related to the overall decommissioning activity (if required, including the period of post decommissioning)?
- (d) Is there evidence that the proposed timeframes might compromise safety (e.g. based on experience)?
- (e) Is the duration of any short-term period of elevated risk justified, and as short as possible?
- (f) What is the influence of the timeframe on the safety of the proposed decommissioning actions (e.g. weather conditions on special decommissioning steps, expected lifetime of safety relevant SSCs)?
- (g) Are any of these timeframes prescribed by the regulations and criteria? Are the proposed timeframes consistent with regulatory requirements, criteria, and guidance?
- (h) Are aspects of loss of institutional memory considered?
- (i) Are aspects of facility ageing considered?

- (j) Is the influence of the availability (timeframe) of waste management (e.g. processing, storage) capacities onto decommissioning safety addressed?
- (k) Are the uncertainties associated with timeframes for decommissioning addressed and how?

### **5.2.5. Endpoints of the decommissioning stages**

Correct identification of appropriate start and end points of each decommissioning stage is a key aspect of the safety assessment process, both in single stage and multi-stage decommissioning.

Here the Regulatory Body needs to focus on the safety related aspects of the decommissioning plan. The following questions may provide some help in this review:

- (a) If the overall decommissioning is divided into stages with separate safety assessments, are the interfaces with previous and succeeding stages consistent? Especially, are the start points and end points of each stage clearly defined in regard to both timeframes and extent?
- (b) What uncertainties are associated with the endpoint and are these clearly indicated and described (e.g. characterization of rooms or hot cells which can only be carried out once early decommissioning operations have been completed)? If there is significant uncertainty, what is the impact on the safety either of the decommissioning or on the public and environment after final termination of the decommissioning activities?
- (c) Does the safety assessment adequately define the endpoints? Are the chemical, radiological and structural (if any) starting and end-points clearly presented? What are the types and quantities of hazardous material, what are the detailed radiological objectives, what is the safety of remaining structures and buildings?
- (d) For a multi-stage decommissioning, do the outputs (endpoints of individual stage) match the inputs (start-point of the next stage), both in time and space?
- (e) Where the safety assessment assumes the presence of SSCs, will these be present and in a suitable and sufficient state to perform their safety function(s) at this point in the decommissioning?
- (f) Where mitigating measures are used, is the safety significance associated with such measures appropriate and justified for the period during the decommissioning plan that they are required for?

### **5.2.6. Requirements and criteria**

Meeting the requirements and criteria set by regulations and the Regulatory Body is a key consideration of the regulatory review. Importantly, failing to recognize relevant requirements and criteria during the preparation of a decommissioning plan and optimization process may result in deficiencies relevant to safety.

The reviewer therefore needs to confirm that all safety relevant criteria that apply to safety and protection of workers, public, and the environment during the decommissioning, and against which the acceptability of the safety assessment will be evaluated, are identified and taken into account (Appendix II provides a non-exhaustive list of safety relevant criteria).

The following list of questions may support a systematic review of the requirements and criteria:

- (a) Are relevant safety requirements and criteria clearly described, or can they uniquely be identified including references to reliable sources?
- (b) Are derived criteria (such as site-specific release criteria) consistent with the safety assessment?
- (c) Are the newest versions of relevant requirements and criteria taken into account? If not, is this appropriate?
- (d) Are all relevant requirements and criteria (e.g. as per the list in Appendix II) considered? Are there further international requirements which are relevant?
- (e) If institutional control is proposed after termination of the decommissioning, are the related requirements and criteria mentioned to allow (if asked for) the safety assessment for abnormal operation of the required systems?
- (f) Are all requirements and criteria listed in a comprehensive manner, and adequate margins defined and justified by the operator?

### **5.2.7. Assessment outputs**

As mentioned earlier in this report, the main objective of the safety assessment is to demonstrate the safety of the proposed decommissioning activities to the Regulatory Body and also to other interested parties. To achieve this, the operator will need to show that the safety assessment outputs meet all relevant requirements and criteria.

The following questions help the performance of a systematic review of the safety assessment outputs:

- (a) Are all proposed safety assessment outputs relevant, clear, realistic, complete and suitable to demonstrate that all relevant safety requirements and criteria for decommissioning and safety assessment objectives can be met?
- (b) Do the proposed safety assessment outputs take into account safety assessment assumptions such as timeframes, critical groups and the defined endpoints?
- (c) Does the safety assessment state the limits, controls and conditions that the operator must apply in order that the assumptions will be met?
- (d) Do the proposed safety assessment outputs support the decisions that will be based upon them? Are the outputs suitable for direct comparison with regulatory or other acceptance criteria?
- (e) If the review is part of a wider regulatory review process, do the assessment outputs meet the expectations of other review teams?
- (f) If the safety assessment criteria include optimization, are the outputs suitable to ensure optimization can be achieved?

### **5.2.8. Safety assessment approach**

The nature of the approach used by the operator to perform the safety assessment can have a significant impact on the results, i.e. on the demonstration of safety. This is especially relevant to the application of the graded approach on safety assessment in decommissioning, which is described in detail in Annex II of this report. Therefore the regulatory review needs to consider whether the safety assessment approach applied is fit for purpose.



The following questions can support a systematic review of the safety assessment approach:

- (a) What safety assessment approach is applied (e.g. deterministic or probabilistic, conservative or realistic, generic or site-specific)? Is it clearly described?
- (b) Is there a justification for the selection of the safety assessment approach?
  - Is the safety assessment approach applied appropriate to the magnitude and type of hazards and risks (e.g. based on experiences or on information such as that provided in Annex II of this report?)
  - What approach has been adopted to identify sources of hazard?
  - What approach has been adopted to identify initiating events?
  - What approach has been adopted to identify hazards and accident scenarios that could lead to becoming realised?
  - Is the methodology for screening and grouping initiating events, scenarios and hazards appropriate?
  - Does the approach take adequate account of experience and feedback from other similar or related decommissioning activities (including international experience)?
- (c) Are multiple approaches used and justified (e.g. in complex cases)?
- (d) What is the nature of the data used in the safety assessment in terms of generic vs. site-specific? What are the consequences with respect to the degree of conservatism of the results of the safety assessment?

### 5.2.9. Existing safety assessments

It is possible that portions of the safety assessments performed to support the operational phase of the facility may remain applicable to the decommissioning safety assessment. Where information from these assessments is used in the decommissioning safety assessment, the reviewer needs to confirm that this information remains valid for the present safety assessment, bearing in mind that the activity of decommissioning is fundamentally different from operation of the facility.

The following questions can assist the performance of a regulatory review in a systematic way:

- (a) Are any previous safety assessments that are relied upon in the present assessment clearly identified and described to a level appropriate to the safety assessment to be reviewed?
- (b) Are the methodologies used in the previous safety assessments appropriate and valid for the current assessment and the decommissioning activities that are listed in the decommissioning plan?
- (c) If the safety assessment presented is a follow up or update of an earlier safety assessment which has been already reviewed by the Regulatory Body, does the safety assessment approach take into account the outcomes of the previous safety assessment and of the related regulatory review?

- (d) Are the scope and assumptions used in the previous safety analysis still relevant?
- Can any credited barriers (SSCs) to release in the previous safety assessment still be relied upon?
  - Does the effectiveness of the engineered barriers, particularly when these are to be removed, partially removed or modified, continue?
  - Is there evidence of new hazards due to the ageing of components (e.g. electric cables, ventilation systems) and structures (e.g. from corrosion) which were not taken into account in the previous safety assessment?
- (e) Do the decommissioning activities within the decommissioning plan make the safety relevant conditions and assumptions of the previous safety assessment invalid?
- Are new hazardous materials (e.g. solvents or combustibles) introduced in the facility, or new initiating events (e.g. new ignition sources) generated that could affect the results of the previous safety assessment?
  - Are contaminants transformed to more dispersible forms (e.g. from cutting operations)?
  - Does the introduction of new equipment or supporting equipment/facilities lead to exceeding relevant safety parameters that were applied in the original safety assessment?
  - Does progressive access to parts of the facility that were not accessible during operation (e.g. may not be appropriately shielded) undermine the logic and results of the previous safety assessment?
  - Are risks related to new neighbouring activities, including decommissioning activities, considered to affect the validity of the previous safety assessment?
  - Do any new interfaces make the results of the previous safety assessments invalid?
- (f) Are existing controls and operating limits made infeasible due to the change of boundary conditions (e.g. the involvement of different staff compared to when the facility was operational)?

### **5.2.10. Safety management measures**

The operator's responsibility for safety is carried out through a safety management programme that covers a wide range of activities including, among other things, the preparation of the safety assessment, internal review and the proposal and acceptance of limits, controls and conditions to ensure safety through all stages of decommissioning.

The regulatory review of the operator's safety management programme is a very important part of the overall regulatory review of the decommissioning plan. The review of the management programme for safety assessment is normally carried out as part of the review of the overall safety management programme, but also forms part of the review of the safety assessment to verify that it is appropriate in terms of scope and necessary detail.

If the Regulatory Body's review of the operator's safety management programme demonstrates that it is both comprehensive and effective, this may give the Regulatory Body sufficient confidence that it may not need to carry out a detailed review of every aspect of the safety assessment for decommissioning. The Regulatory Body may therefore choose to concentrate its efforts and resources on only those aspects of the safety assessment which it considers to be most critical to safety.

The following key questions related to safety assessment for decommissioning and their relationship with the safety management programme should be considered together with other questions applicable to all safety management programmes:

- (a) Does the safety management programme include internal review that will have as one of its goals to check the accuracy of the safety assessment and its consistency with the rest of the decommissioning plan?
- (b) Is the report on the operator's internal review adequate to demonstrate the effectiveness of internal review?
- (c) Does the quality management programme assure the correctness of input assumptions to the safety assessment to a depth and level of detail appropriate to the hazards being addressed within the decommissioning plan?
- (d) Does the quality management programme include provisions to implement limits, controls and conditions based on the results of the safety assessment?

### 5.3. REGULATORY REVIEW OF THE DESCRIPTION OF FACILITY AND DECOMMISSIONING ACTIVITIES

The following information needs to be included in the safety assessment or referenced to the relevant section(s) within the decommissioning plan to avoid unnecessary repetition.

#### 5.3.1. Facility description

The regulatory review needs also to seek an answer to the following question:

Does the description of the facility contain all relevant information for the safety assessment in sufficient detail?

- Does the description of the site, the surroundings and the population provide all information in sufficient detail to support the understanding of the calculations of dose and risk performed in the safety assessment?
- Are the critical groups for the evaluation of the radiological consequences and the related assumptions adequately described and justified?
- Are any interdependencies with other facilities on the site or close to the site described in sufficient detail to support an understanding of safety relevant impacts during decommissioning (e.g. power and water supplies)? If safety relevant impacts exist, are they clearly identified and explained?

#### 5.3.2. Safety related systems, structures and components and safety measures

The SSCs that are to be decommissioned (or are relevant to safe decommissioning) need to be clearly and consistently defined within both the safety assessment and the decommissioning plan. Their planned evolutions (degradations, decommissioning or any substantial modifications) and their reliability need to be clearly described, as well as the new SSCs that will be needed to prevent or contain the spread of radioactive or hazardous material during decommissioning. The reviewer needs also to consider the extent to which interactions and links between different SSCs might prejudice safety, to ensure that appropriate performance and delivery of safety function(s) will be achieved throughout the decommissioning. A similar approach needs to be undertaken for operating limits,

controls and conditions that need to be implemented in order to carry out the decommissioning activities safely.

The following questions can assist a systematic review of the SSCs and control approach presented in the safety assessment for decommissioning:

- (a) Is the information on SSCs sufficient with respect to the safety functions implemented?
  - Are the SSCs clearly described taking into account expected evolutions (e.g. degradation, decommissioning, substantial modifications) with time or with progress of the decommissioning activities?
  - Is the impact of SSCs on safety during decommissioning clearly described taking also into account interdependencies between SSCs?
  - Is the reliability of SSCs during the decommissioning described with sufficient detail and clarity?
  
- (b) Are the explanations of existing safety measures (such as controls and operating limits) sufficient with respect to safety aspects? More specifically:
  - Are controls and operating limits clearly described and explained with respect to their impact on safety during decommissioning?
  - Do the explanations of the controls and operating limits take account of changes in circumstances as the decommissioning work proceeds?
  - Do the explanations describe the conditions to preserve the safety functions and measures (e.g. work control procedures, personal protective equipment, training and testing programmes, radiation protection programmes)?

### **5.3.3. Radiological characterization**

The characterization of the radioactive inventory needs to include relevant radionuclides and their distribution in contaminated and/or activated components and building structures of the facility to be decommissioned. The reviewer needs to verify that the radioactive inventory is complete and that it was determined on the basis of reliable radiological surveys, calculations, or operational records and is of an appropriate level of detail. The following questions can support the regulatory review of the radiological characterization:

- (a) Does the description explain the radioactive inventory and its characteristics in sufficient detail? More specifically:
  - Is the radiological inventory described consistently and with sufficient detail and associated uncertainties? Are fixed and loose radioactive contamination separately?
  - Are contaminated or potentially contaminated areas, structures, systems or components explicitly mentioned?
  - Is the methodology used to determine the radiological inventory and its characteristics adequately explained? Are the systematic uncertainties related to the methodology explained with sufficient detail?

- Has the compilation of the radioactive inventory taken adequate account of the operational history of the facility and associated records (see the following Section 5.3.4)?
- Is there evidence that all locations within the facility where radioactive material may exist have been taken into account within the assessment?
- In multi-stage safety assessments, how has the initial inventory been updated to account for decommissioning progress during the individual stages?
- Do the descriptions of the radiological inventory support an understanding of their impact on safety? In particular, are the methodologies for detection and related detection limits addressed?
- If inventory data is used in different sections or parts of the documentation, is it cited and used consistently?

#### **5.3.4. Operational history**

With respect to the regulatory review of the use of operational experience in the safety assessment for decommissioning the following main questions need to be asked:

Is the operating history described with sufficient detail so that effects on the (conventional / radiological) safety during decommissioning can be identified (if any exist)? More specifically:

- Is the normal operation described clearly, including information on the radioactive materials involved, to support a clear understanding of possible failures and associated hazards which may have an impact on decommissioning activities?
- Is the history of facility modifications known and adequately taken into account?
- Is there a clear statement on whether past incidents and events at the facility have been taken into account?
- If past incidents and events have occurred, are they clearly described and are their consequences with respect to safety during decommissioning explained?

#### **5.3.5. Decommissioning activities and techniques**

The following questions will assist the regulatory review of the description of the decommissioning activities and techniques in the safety assessment:

- (a) Does the description of the proposed decommissioning activities provide a clear understanding of the safety relevant consequences? More specifically:
  - Are the decommissioning activities described in sufficient detail to support the safety assessment? Are aspects like deactivation or removal of major recoverable hazards, decontamination/removal of fixed contamination, dismantling of systems and equipments, demolition of major structures, and remediation of residual contamination of the site addressed?
  - Are the decommissioning activities and their sequences clearly presented? In particular, are dependencies between the individual decommissioning activities clearly defined?

- (b) Does the description of the proposed decommissioning techniques allow a clear understanding of relevant hazards and safety impacts of the proposed activities? More specifically:
- Are the proposed decommissioning techniques proven? If not, have appropriate uncertainties been built into the safety assessment?
  - Are the decommissioning techniques to be used compliant with safety requirements and criteria?
  - Is the choice of decommissioning techniques appropriate to the risks and hazards?

### **5.3.6. Waste management**

The regulatory review needs to seek answers to the following questions related to safety of management of waste resulting from decommissioning:

- (a) Is the waste and materials management clearly and consistently described supporting an analysis of its impact on safety during decommissioning? If waste and materials management is not taken into account, what is the justification?
- (b) Are waste management (e.g. conditioning, packaging and handling) activities adequately described?

### **5.3.7. Supporting facilities**

The following question needs to be asked when reviewing the consideration of supporting facilities in the safety assessment for decommissioning:

Is the influence of existing, modified or new supporting facilities and other facilities sufficiently explained? More specifically:

- Are supporting (new, existing or modified) systems or facilities relevant for safety clearly indicated, described and is their influence on safety explained in sufficient detail? In particular, is it clearly defined how these systems or facilities influence either the facility to be decommissioned or its systems, structures and components during the decommissioning activities?
- Is information provided on when supporting systems and facilities will be needed and how they may change operating limits, controls and conditions within the facility to be decommissioned?
- Does the information provided in the safety assessment (including hazards analysis) justify the operation of supporting (e.g. new, existing, modified) facilities?
- If supporting facilities are subject to a separate application for licensing (including safety assessment), is there clear evidence that sufficient information (particularly relating to inter-dependencies between facilities) has been provided by the licensee of the supporting facilities to support the decommissioning safety assessment?

### **5.3.8. Final end-state**

The following key questions need to be asked in the regulatory review of safety assessment for decommissioning:

- (a) Does the safety assessment adequately define the final end-state?

- (b) If the final end-state requires some institutional controls (e.g. monitoring) – are these controls within the scope of the safety assessment? If yes, does the safety assessment contain related assessments and resulting statements? What parameters still need to be monitored?
- (c) Will radioactive waste continue to be stored on site following the completion of decommissioning? If so, is this justified and supported by a suitable safety assessment?

#### 5.4. REGULATORY REVIEW OF THE HAZARD IDENTIFICATION AND SCREENING

The primary objective of this section is to describe aspects of the regulatory review process used to judge whether the hazard identification and screening has been conducted in an acceptable and justified manner (i.e. by using appropriate methods or approaches). The details of the hazard identification, preliminary assessment and screening may be contained in supporting documents and not in the main safety assessment documents. Using a graded approach, the Regulatory Body may choose whether or not to request and review these detailed supporting documents, depending upon the hazards to workers, public and the environment, associated risk and complexity of the decommissioning activities.

##### 5.4.1. Hazard identification

One of the first steps in developing the safety assessment for decommissioning activities is the identification of all existing hazards together with further hazards arising from the decommissioning activities to be undertaken (Volume I of this report). The key questions to be answered in this part of the review are as follows:

- (a) Have all reasonably foreseeable hazards, initiating events and scenarios been addressed? Taking into account the specific situation of the facility and of the decommissioning stage, are hazards or initiating events missing when compared to either an existing standard set of typical hazards (see e.g. Appendices IX and X in the main report) together with the reviewers' experiences and expectations?
- (b) Are all relevant hazards identified (e.g. radiological, toxic and industrial) identified for all steps of the proposed decommissioning activities?
- (c) Are these hazards combined and additive effects considered adequately, and has the extent to which they could give rise to radiological consequences (e.g. fire leading to a loss of containment) to workers, public and the environment been addressed?
- (d) Is the process used to identify the initiating events and sequences clearly described in the safety assessment? Does the process applied by the operator meet the regulatory expectations?
- (e) Are the initiating events and event sequences that could lead to the realization of these hazards identified and evaluated through a systematic process, and are the initiating events and sequences clearly described in the safety assessment? Does the process methodology meet the regulatory expectations?
- (f) Are new potential sources of exposure arising from the proposed decommissioning activities included in the identification of hazards and initiating events?
- (g) Has future accumulation of radioactive material at the site been considered?
- (h) Have waste management activities been included in the safety assessment?
- (i) Are potential and likely human errors taken into account?

- (j) Does the hazard identification and evaluation process consider higher risk activities for short periods during decommissioning? In such cases, is a justification of the short-term elevated risks provided, based on significant and long-term reduction in hazards and their associated risks?
- (k) If the chosen strategy is deferred dismantling, have the hazards and risks associated with long-term deferred period been adequately addressed?

### **5.4.2. Approaches to hazard identification**

The key question to be answered in this part of the review is the following:

Have the hazards, initiating events and the sequences identification methods used been validated, proven, and shown to be suitable for the situation, and have they been applied appropriately?

Supporting questions that may help in answering this key question include:

- Is the hazard, initiating event and scenario identification process commensurate with the hazard potential and the complexity of the facility concerned?
- Are the methods used appropriate to the dynamic nature of facilities during decommissioning?
- If approaches or methods used within other process industries (e.g. oil and gas production and refining, mining, chemical industry, etc.) are applied, are they appropriate for a decommissioning safety assessment?
- When existing safety assessments for similar activities are used, have they been previously reviewed and accepted? Are these assessments applicable to the present case?
  - (i) Are the inventories of hazardous materials the same? If there is some new hazard(s), was it included?
  - (ii) What was the result of experience feedback concerning the former safety assessment and the real situation for which that decommissioning plan was prepared?
- When feedback from past operational experience is used to identify hazards, initiating events and sequences, what is the source of the information? Is the situation sufficiently similar to serve this purpose?
- Has the approach been applied to the various steps of decommissioning as different hazards and initiators are removed and introduced during decommissioning?
- When dose rate maps have been used for assessing radiological hazards, how were these maps compiled and on what basis? Do they reflect current and future situations, taking due regard of new and altered sources of exposure, e.g. as shielding material is removed or dismantled? Is the accumulation of radioactive waste during temporary storage at the facility taken into account?

### **5.4.3. Preliminary hazard assessment and screening**

The aim of the review of preliminary assessment and screening is to decide whether the decisions of the operator on screening out negligible or not relevant hazards are acceptable. This screening will lead to a reduced list of hazards and initiating events which will be the focus of the safety assessment. The key question to be answered in this part of the review is as follows:



Are the decisions made by the operator on screening out low hazards, initiating events or unlikely scenarios from the list of hazards justified and acceptable?

Supporting questions that may help in answering this key question might include:

- What are the screening criteria for preliminary hazard assessment and how are they applied?
- Is the screening approach used documented, justified and appropriate?
- Is justification provided for the excluded hazards, initiating events and scenarios? What criteria were used, and are they acceptable?
- Does the hazard, initiating events and scenario screening process consider all relevant exposure pathways within the facility to workers carrying out proposed decommissioning activities and to other potentially affected members of the public?
- During the initial screening, have hazards and initiating events been quantified taking no benefit from any protective measures or control to be utilized at the facility during decommissioning other than intrinsic (passive) features where these remain during the specific decommissioning activity that gives rise to the relevant hazard?
- Have any hazards, initiating events or scenarios with the potential to cause significant damage been inappropriately screened out?
- When a hazard or scenario is excluded, has justification for that decision been provided?

## 5.5. REGULATORY REVIEW OF THE HAZARD ANALYSIS: EVALUATION

This section describes those parts of the regulatory review related to the hazard analysis. There are two main aspects considered here:

- The choice of scenarios to be modeled; and
- The modelling or calculation techniques themselves.

The choice of scenarios is further divided into normal and accident scenarios in the first two subsections.

### 5.5.1. Analysis of normal scenarios

The term “normal activities” refers to the planned or intentional conduct of decommissioning activities, as opposed to unplanned or accidental events. It should be noted that the questions used to support the “normal activities” review are also relevant to the Accident Scenario section (5.5.2) and should be used as part of that review as well as for this section.

The key question to be answered in this part of the review is as follows:

Are the decommissioning activities for which the assessment is performed consistent with the complete list of all proposed activities within the stated scope of the safety assessment (e.g. from commencement of decommissioning operations to waste transportation outside the site), and is the analysis for these activities adequate?

Supporting questions that may help in answering this key question might include:

- (a) Is each activity clearly described and documented in terms of:
  - Source and magnitude of radiological hazard (e.g. the inventory characteristics and source term location, dimensions, spatial distribution, constituents, quantities);
  - Activities and scenarios that could lead to these hazards being realised (i.e. frequency of occurrence of the activities, exposure pathways, assumptions necessary to support the calculation of frequencies and consequences during normal and accident conditions);
  - Consequences (dose rate and occupational doses; with or without protective measures, etc.);
  - Uncertainties (e.g. quality of assumptions used, appropriateness of any conservatism applied, etc.);
  - Prevention measures (e.g. work controls);
  - Protection measures (e.g. safety-related structures, systems and components); and
  - Mitigation measures (e.g. containment)?
- (b) Are clear links provided between the initiating events, hazards scenarios and exposure pathways and the activities?
- (c) Are mitigating measures identified and are they likely to be effective? Are clear links provided between the initiating events and the safety and mitigating measures?
- (d) Is the defence-in-depth approach applied adequately and justified rigorously within the safety assessment? Do activities, scenarios and event sequences take into account the need to meet a single-failure criterion (redundancy, multiple barriers, etc.) so that loss of a single component or barrier does not jeopardize the safety function?
- (e) Has the removal or addition of controls as the decommissioning proceeds, due to the removal of some hazards and the possible introduction of other hazards, been analyzed?
- (f) Are hazards from materials during handling and processing analyzed?
- (g) Have non-radiological hazards been addressed, including exposures to electrical and mechanical hazards and physically hazardous activities, including entry into confined spaces, lifting hazards, etc.?
- (h) Is the safety assessment consistent with the work control and occupational radiation protection procedures?
- (i) Are assumptions related to the existence and effectiveness of barriers to exposure or release consistent with the state of structures and systems that will be prevailing at the time the activities will be carried out?
- (j) In the case of potential discharges of radioactive or hazardous materials, have the relevant potential pathways for exposure been addressed (for example, direct radiation, contamination, inhalation or ingestion)? Is the choice of the critical group for dose assessments appropriate to the pathway under assessment?

- (k) If there are particular activities or scenarios for which regulations or other regulatory documents prescribe that hazard assessments must be carried out, has this been done?

### 5.5.2. Analysis of accident scenarios

In the case of accident scenarios, the considerations addressed and questions proposed in the previous Section 5.5.1. on normal activities also apply. The key additional question for this part of the review is:

Is the list of accident scenarios complete and representative?

In addition to the list of suggested questions in the previous section, some additional supporting questions that may be asked include:

- For each scenario, does the safety assessment describe:
  - (i) The type, duration, potential causes and estimated likelihood of the scenario?
  - (ii) The potential consequences to workers, the public and the environment?
- Do the scenarios analyzed include loss of services, operational events, external events due to human activities outside the facility and external events arising from natural phenomena? Are they consistent with the hazard, initiating event and sequence review?
- If bounding scenarios are used, are they described adequately and are they both representative and conservative?
- If selected scenarios are used to represent a broad range of specific scenarios, do these representative scenarios adequately represent the full range hazards and initiating events to be covered in a conservative fashion?

### 5.5.3. Modelling and calculation of consequences

The key question in the regulatory review of this part of the safety assessment for decommissioning is:

Do the consequence calculations provide an adequate representation of the likely harm to the public, workers and the environment arising from the proposed activities and of what could occur if an accident was to take place?

Some supporting more detailed questions include:

- Are the complexity and extent of the calculations adequate and commensurate with the hazard potential of the facility and decommissioning activities that are being analyzed? What is the basis for selection of the modelling approach?
- Are the assumptions presented and clearly documented in the safety assessment?
- Are the inputs consistent with the expected conditions in the facility?
- If probabilistic safety analysis methods are used, are the failure rates, fault frequencies and probabilities used in the analysis appropriate? (Further guidance on the review of such probabilistic safety assessment can be found in Ref. [34].)
- Is the level of detail adequate to the safety assessment objective and the knowledge of the system?

- What alternative conceptual and mathematical models have been tested in order to confirm that the selected model is adequate for the specific situation?
- What validation, verification and calibration tests of the code have been performed? Do they demonstrate the code's ability to correctly solve the mathematical equations used in the safety assessment and to adequately represent the disposal system?
- What model or code inter-comparisons and peer reviews have been performed?
- What evaluations of modelling uncertainties have been performed?
- Has any sensitivity analysis been carried out? Are there key datasets which if modified slightly significantly change the outcome of the models and calculations?
- What are the inputs to the models and codes used to perform the calculations?
- Have these inputs been justified relative to the actual conditions at the site?
- Are the input data for calculations consistent with the facility description information and are assumptions about protective measures or about physical processes justified (or conservative), given the expected state of the facility?
- Have the models, codes and their input data been used within their limits of applicability?

## 5.6. REGULATORY REVIEW OF ENGINEERING ANALYSIS

The key questions to be addressed during the review of engineering analysis are:

- (a) Are the engineering classifications and standards used (e.g. electrical, control system, pressure boundary, etc.) consistent with the conditions and requirements assumed in the safety assessment for decommissioning?
- (b) Is the operator's management of the facility, in terms of testing, inspection, examination and maintenance of all engineering equipment and the facility, adequately considered and justified in the safety assessment?
- (c) Does the safety assessment adequately address both the physical evolution of the site and the associated changes to procedural limits, controls and conditions as decommissioning proceeds?

A list of suggested more detailed additional questions follows:

- Have all SSCs whose functioning is required to ensure acceptable outcomes in the safety assessment been identified as safety-related, and suitably qualified and justified for the conditions to a standard commensurate with their safety significance?
- Do the safety assessment results confirm that existing and new safety-related systems and components are suitable and sufficient to achieve the desired reduction of doses and risks?
- Has the safety assessment evaluated the suitability, sufficiency and reliability of the safety related SSCs to perform their safety functions for the entire duration of the decommissioning? In the case of a deferred decommissioning strategy, does this include the period of storage with surveillance?
- Does the safety assessment take due account of ageing and other degradation mechanisms as well as invasive decommissioning activities (e.g. demolition of supporting walls, creation of dusty environment) on the ability of SSCs to perform their functions?

## 5.7. REGULATORY REVIEW OF THE IMPLEMENTATION OF THE RESULTS OF THE SAFETY ASSESSMENT AND SAFETY MEASURES

It is required [18] that the safety assessment is used to aid the implementation of limits, controls and conditions placed on decommissioning by the operator. Since the safety assessment system is intended to be not only a demonstration of compliance to the Regulatory Body, but also an integral part of the operator's management of safety, it is important that the regulatory review of the safety assessment evaluates also how the safety assessment will be used within the safety management programme so that appropriate safety measures and controls are applied.

The following questions can be of support of the regulatory review:

- (a) Does the safety assessment provide systematic information on the consequences of proposed operations and test their robustness of preventative, protective and mitigating measures both in normal and accident conditions?
- (b) Does the safety assessment demonstrate that the choice of decommissioning activities, their timing and the order in which they are to be undertaken has been optimized in regard to dose, risk and environmental impact?
- (c) Does the safety assessment demonstrate that the choice of safety measures and controls has been optimized in regard to dose, risk and environmental impact?

### 5.7.1. Comparison of analysis results with criteria

The key questions that can be used in the review of this topic in the safety assessment for decommissioning are:

- (a) Are the safety assessment results within relevant regulatory requirements and criteria with an adequate margin?
- (b) Are the safety requirements and criteria used for each activity and scenario appropriate to the activity or scenario being analyzed?

Even if the predicted risks are acceptably low, the regulatory review of the safety assessment and decommissioning plan needs to consider the extent to which the operators have considered the following aspects:

- Are the doses and risks below the safety criteria and as low as reasonably achievable at all times?
- Is the timing of the decommissioning in line with good practice and national policy?
- Is the safety assessment fit for purpose?
- Are the safety arguments sufficiently transparent and not obscured in a large suite of inter-referenced documents so that the key safety issues become difficult or impossible to understand?
- Are temporary increases in risks and hazard potential as short as possible?
- Have the safety assessment outputs been subject to optimization (particularly with regard to dose and risk)?
- Is the overall balance of risk across linked facilities and activities optimized?

- Has an appropriate balance been achieved between short term and long term risks? Equally, can any relatively high short term risks be justified given the eventual removal of hazard potential? Such balances need to be treated with caution since future risks are not easy to define with confidence and it is difficult to compare risks and hazards on a common basis.

In some cases, the safety management process may include an optimization step which attempts to reduce the consequences of normal or accident scenarios to a practicable extent. In such cases, the regulatory review of the safety assessment needs also to check that this optimization process has been conducted appropriately, taking into account both the margin between the results and the required criteria and social and economic factors.

### **5.7.2. Types and treatment of assumptions and uncertainties**

The key questions related to the treatments of assumptions and uncertainties are as follows:

- (a) Are areas of uncertainty clearly defined? Are uncertainties dealt with appropriately?
- (b) Are the data and assumptions within the applied safety assessment approach reliable and appropriate for the safety assessment to be performed?
- (c) What key assumptions have been made in developing the safety assessment? In particular, are all operational controls, measures and limits presented and considered as required in the assessment captured in the outputs?
- (d) Could potential uncertainties (e.g. accuracy of assumptions, etc.) within the assessment alter the results to a point where they significantly affect the conclusions? If so, has an uncertainty analysis been performed?
- (e) Does the safety assessment identify and assess which parameters have the highest impact on the assessment results and subsequent consequences?
- (f) Does the safety assessment address the assumptions and uncertainties associated with these parameters?

Some possible detailed questions:

- What is the approach used to treat the uncertainties? What techniques have been used to systematically assess the impact of uncertainties and are they properly justified?
- What are the recognized sources of uncertainties? Have they been quantified and is the quantification reliable? If they are not quantified, is there a justification? Which of the uncertainties have been quantified and which are just qualitatively evaluated?
- Have sensitivity analyses been performed in order to identify and assess those parameters and values with the highest impacts on the assessment results?
- What input parameters or assumptions are the results particularly sensitive to?
- What efforts has the operator taken towards reducing the uncertainties and repeating the safety assessment? Do they meet the regulatory expectations and allow a staged approach to be considered with information generated by the earlier decommissioning activities being reviewed to assess if there is any impact on the safety assessments associated with later decommissioning activities?
- Have attempts been made to reduce or minimize uncertainties and if so, how?

### 5.7.3. Safety measures (limits, controls and conditions)

The key questions to be addressed during the review of safety measures are:

- (a) Are the safety measures, including procedural limits, controls and conditions applied by the operator as well as engineered measures, consistent with the results of the safety assessment? Is the operator's implementation of operating limits, controls and conditions consistent during decommissioning with the safety assessment and regulatory expectations?
- (b) Does the outcome of the safety assessment identify the limits, controls and conditions that will need to be applied to the decommissioning activities to ensure that the requisite safety requirements and criteria are met and maintained throughout the decommissioning?
- (c) Does safety assessment identify necessary preventative, protective and mitigating measures and justify that these will be suitable and sufficient to achieve ensure safety during decommissioning in compliance with relevant safety requirements and criteria?

### 5.8. REGULATORY REVIEW OF THE GRADED APPROACH

The objective of the regulatory review of safety assessment is to determine whether the assessment has been conducted and reported in an acceptable manner and to an adequate level of detail (see Section 4.1 of this annex). The fundamental questions regarding the implementer's application of the graded (safety focused) approach should therefore seek to confirm that the level of detail and complexity of the safety assessment are sufficient to address the following questions (see Annex II of this report):

- (a) Have the applicable and relevant requirements been properly identified and addressed in the safety assessment?
- (b) Is there evidence that the list of hazards and initiating events identified during the preliminary screening analysis is not missing any hazards or events whose inclusion might significantly affect the outcomes of the assessment?
- (c) Has the radiological categorization of the facility and its systems been sufficiently detailed to ensure that all areas and systems where radioactive contamination might be encountered during the work have been identified and assessed?
- (d) Do the scope, extent and level of detail of safety assessment correspond to the types of hazards and initiating events and their potential consequences?
- (e) Is the application of the safety assessment results to documentation, training and procedures adequate to ensure safety during decommissioning?

The review of the application of the graded approach is also an integral part of the rest of the review and not a separate review task. At many points in the regulatory review described in preceding sections of this report, the main task of the reviewer is to confirm whether the implementer's assessment has adequately addressed the requirements for the safety assessment. This includes confirming that the application of the graded approach has not impaired the reviewer's confidence in the safety assessment. That is, after the application of the graded approach, the safety assessment must still provide sufficient evidence, commensurate with the magnitude of the hazards and the characteristics of the facility, that the safety requirements and criteria will be met during the decommissioning.

## 5.9. REGULATORY REVIEW OF CONFIDENCE BUILDING IN THE SAFETY ASSESSMENT

### 5.9.1. Safety management system

It is not the purpose of this report to describe the requirements for safety management programmes as these are presented in Ref. [21], nor is it intended to give detailed recommendations on how to review such a programme. For more information on this subject, consult the requirements and guidance for safety management programmes in Refs [21, 28].

A few key questions related to safety assessment for decommissioning follow:

- (a) Have models for safety assessment been adequately defined?
- (b) Have validation and review of input data, methodologies, modelling, procedures and results of safety assessment been carried out by the operator using suitably independent teams to ensure the assessments are appropriate, comprehensive and consistent with the decommissioning plan?
- (c) Have computer codes used for safety assessment been qualified and validated?
- (d) Do personnel performing the safety assessment, as well as those performing internal reviews and audits, have appropriate qualification, experience and training, and have they been assigned clear responsibilities?

### 5.9.2. Change Management Process

The operator's change management process normally includes a mechanism for evaluating the significance of any change, the need for additional assessment and safety controls, the documentation affected or required by the change, and the approval and training, emergency, radiation protection or monitoring measure and programmes, necessary for implementing the change.

In reviewing the application of this process to safety assessment of decommissioning, the following questions may be helpful:

- (a) Are changes to the safety assessment documented?
- (b) Does the documentation include descriptions, technical justifications, effective dates, implementation, internal approvals, and if required, regulatory approvals?

## 6. OUTCOMES OF THE REGULATORY REVIEW

The regulatory review of the safety assessment needs to evaluate whether the outputs meet established requirements and criteria with a suitable margin.

In the case when the outputs of safety assessment are close to or exceed the established requirements or criteria, or where the quality of the safety assessment is not sufficient to give confidence that safety requirements and criteria will be met, the Regulatory Body needs to decide what action needs to be taken. The scope of the alternatives here will depend on national legislation and could include:

- (a) Reject the decommissioning plan and request a resubmission;
- (b) Reject the safety assessment and request a resubmission;



- (c) Request a re-submission of specific parts of the safety assessment/decommissioning plan;
- (d) Permit part of the decommissioning to proceed pending submission of a further safety assessment;
- (e) Permit the full decommissioning to proceed subject to additional regulatory controls; and
- (f) Permit the full decommissioning to proceed as proposed by the operator.

For all of these alternatives except the last one, the operator needs to be given an opportunity to rectify the deficiencies before regulatory restrictions are imposed. Therefore, the Regulatory Body needs to discuss the outcomes of the regulatory review with the operator to explain what conclusions were reached and why, and the operator needs to be given an opportunity to make corrections.

## **7. APPLICATION OF THE REGULATORY REVIEW PROCEDURE TO DESA TEST CASES**

All Member States represented at the first DeSa project meeting were invited to put forward decommissioning projects that would be suitable for evaluation against the developed DeSa safety assessment methodology. Three test cases were thus selected for the second phase of the DeSa project:

- A nuclear power plant;
- A research reactor; and
- A nuclear laboratory for radiochemical analytical services at a fuel cycle facility.

The regulatory review procedure described in this volume was applied to these test cases with the following objectives:

- (a) To test the regulatory review methodology, as developed after the third DeSa meeting;
- (b) To test the entire DeSa safety assessment methodology;
- (c) To evaluate whether the test case reports met the objectives for a safety assessment and presented all the information needed to make a regulatory decision; and
- (d) To provide inputs for the improvement of the test case reports, the main DeSa report, and the graded approach document.

It is important to note that this quasi-regulatory review filled the role not only of a regulatory review, but also of an independent review within the DeSa project. It was mainly focused on the content, completeness, consistency and clarity of the presentation in the test case report. The review was performed assuming that the description of the facilities, decommissioning activities, criteria, etc. given were correct.

The review process was as follows:

- (a) All the members of the regulatory review working group were invited to review one of the test cases for which they were not involved in the preparation.
- (b) The review team met to compile the comments received from the whole regulatory review working group members.

- (c) During this meeting, the review team went through all the questions in Section 5, checking them individually for the Research Reactor Test Case and at a more general level (section by section) for the other two test cases.
- (d) The comments of the review team were separated into specific comments on the three test case reports and generic comments that had application to the DeSa main document and the graded approach report.

The revised versions of the three test case reports, taking into account the results of the quasi-regulatory review, were prepared and submitted to all DeSa participants in preparation for the final DeSa meeting.

The review of the test cases also identified a number of issues to be addressed by the test case working groups. Approximately 20 specific comments were made for each test case. These comments were forwarded to the test case working groups and were addressed in the final test case reports.

One area that was found to be particularly troublesome was the treatment of interfaces with other systems. Two of the test cases were based on subsets of larger facility decommissioning projects, and there was difficulty in presenting complete enough descriptions of these smaller subsets while avoiding confusion with the larger project. When the facility to be decommissioned is a part of a larger site, or when the test case focuses on a specific part of a larger facility, the interfaces and interdependencies between the facility or the part of facility to be decommissioned with the rest of the site or facility need to be clearly and sufficiently described, and this gave rise to difficulties during the test cases. This kind of difficulty points out that decommissioning projects that are subdivided into separate sub-facilities may pose difficulties during the review, particularly as this affects the completeness of the safety assessment.

A number of the other comments were related to justification and support for assumptions. It is important that adequate support, possibly by reference to other documents, be provided for assumptions made, particularly during the system description and preliminary screening parts of the safety assessment.

The review of the test cases also served to identify points for improvement in the DeSa safety assessment methodology and in the regulatory review procedure (see Section 5 of this report), which have been incorporated into the final reports. A number of issues related to terminology were also identified and needed to be resolved.

Finally, this review served to demonstrate that the regulatory review procedure can be applied to realistic cases of decommissioning, and should therefore be applicable to a wide variety of installations.

## 8. CONCLUSIONS

Regulatory review of a safety assessment for decommissioning is an important part of the regulatory review of a decommissioning plan. Its primary purpose is to support the Regulatory Body's decision-making. In so doing, it also serves as part of the overall demonstration that the proposed decommissioning activities can be performed safely and meet regulatory requirements and criteria.

During the initial part of the DeSa project, information was exchanged by participants regarding lessons related to the review of safety assessments that had been learned during past decommissioning projects. These lessons learned included the following:

- (a) Regulation of decommissioning must not be treated as simply another phase of operation; this can lead to a cumbersome approach that does not respond adequately to the changes that occur during decommissioning;
- (b) The balance in emphasis between technical issues and safety management issues tilts towards management during decommissioning, as the original sources of hazard are removed while hazards resulting from configuration changes increase;
- (c) An approach that allows reliance to be placed on the licensee's internal approval process is preferable than an approach that requires constant regulatory intervention;
- (d) Open and frequent communications between regulator and operator can be very beneficial;
- (e) Early documentation of the safety assessment and early communication with the regulator helps avoid last-minute problems; and
- (f) In addition to the operator's graded approach to safety assessment, the regulator also needs to focus its attention on the most safety-significant issues and adjust the depth of its reviews to correspond to the safety significance of the decommissioning activities.

The DeSa safety assessment methodology and the regulatory review procedure elaborated in this report took these lessons learned into account. They are intended to lead to clear conclusions regarding the adequacy of the safety assessment, and thus help the Regulatory Body gain confidence that the safety assessment has been prepared in a systematic and complete manner.

The regulatory review procedure is presented in the form of a series of questions. It must be kept in mind when applying the procedure that the list of questions in this report is not intended to be exhaustive. Other questions may be added, as appropriate to the safety assessment under review. Moreover, depending on national regulations and criteria as well as on the particular characteristics of the facility being decommissioned, some of the questions given in this report may not be required or relevant. In all cases, the questions should be considered to be guides to the types of issues that should be addressed in order to perform a regulatory review and arrive at a conclusion about the acceptability of the decommissioning plan.

The application of the regulatory review procedure to the DeSa test cases (see main report) has served to demonstrate the consistency of the overall approach to safety assessment described in the other annexes of this Report. The results of the test case reviews during the DeSa project were useful in demonstrating a number of areas where improvements could be made to all of the annexes of the

report. These improvements were incremental, not fundamental, demonstrating the fundamental consistency of the approach.

The lessons learned during the review process of the three DeSa test cases included the following:

- (a) Regulatory review of safety assessment is an integral part of the review of the decommissioning plan. Although the scope of this report is limited to review of safety assessment rather than the review of a decommissioning plan, this should not be interpreted to be a recommendation that the safety assessment review is best performed in isolation. The experience of the test case reviews leads to the opposite conclusion.
- (b) With respect to the conduct of the DeSa project itself, much of the work on the test cases was carried out in parallel with the development and refinement of the regulatory review. This complicated the process. The same will be true outside the DeSa project. The quality of safety assessment can be improved if a regulatory review procedure(s) is developed and made available before safety assessment are performed and submitted for review.
- (c) Decommissioning as a subject covers a very wide range of facilities and safety issues. Any procedure that is intended to cover this wide range is likely to include steps that are more important for some facilities and less important for others. A “one size fits all” approach to regulatory review is likely to cause problems. It is recommended that regulatory review processes be flexible and capable of focusing on the safety issues of most importance in each different decommissioning plan to be reviewed.
- (d) In addition to regulatory review, other review processes are also applied to safety assessment for decommissioning, including internal review processes and a separate step of independent review by staff of the operator or contractors. These reviews carried out by or on behalf of the operator are different processes from regulatory review and have different objectives and outcomes. While the procedures used for these reviews will likely have a number of features in common with procedures for regulatory reviews, there will also be significant differences.
- (e) Nevertheless, although the present regulatory review procedure was written for the use of Regulatory Bodies rather than operators, it represents a useful second viewpoint on the DeSa safety assessment methodology. This procedure could be of assistance to operators performing safety assessment to improve the quality of these safety assessments.

The test cases were based on real decommissioning examples. Successful application of the regulatory review procedures to these test cases thus demonstrates that the DeSa safety assessment methodology and the DeSa regulatory review procedure are applicable to real safety assessments for a wide variety of facilities to be or under decommissioning.

## Appendix I

### EXAMPLE CONTENTS OF A FACILITY DESCRIPTION IN A DECOMMISSIONING PLAN

#### I-1. SITE DESCRIPTION

##### **a. Site location and description**

- The size of the site;
- The state and county in which the site is located;
- The names and distances to nearby communities, towns and cities;
- A description of the borders and features of the site;
- The elevation of the site;
- A description of property surrounding the site; including the location of all off-site wells used by nearby communities or individuals;
- The location of the site relative to prominent features such as rivers, seas and lakes;
- A map that shows the detailed topography of the site using a contour interval;
- The location of the nearest residences and all significant facilities or activities near the site; and
- A description of the facilities (buildings, parking lots, fixed equipment, etc.) at the site.

##### **b. Population distribution**

- A summary of the current population in and around the site, by compass vectors;
- A summary of the projected population in and around the site by compass vectors;
- A list of minority populations by compass vectors; and
- Demographic data by census block group to identify minority or low-income populations.

##### **c. Current/future land use**

- A description of the current land uses in and around the site; and
- A summary of anticipated land uses.

##### **d. Metrology and climatology**

- A description of the general climate of the region;
- Seasonal and annual frequencies of severe weather phenomena;
- Weather-related radionuclide transmission parameters;
- Routine weather-related site deterioration parameters;
- Extreme weather-related site deterioration parameters; and
- A description of the local (site) meteorology.

##### **e. Geology and seismology**

- A detailed description of the geologic characteristics of the site and the region around the site;

- A discussion of the tectonic history of the region, regional geomorphology, physiography, stratigraphy, and geochronology;
- A regional tectonic map showing the site location and its proximity to tectonic structures;
- A description of the structural geology of the region and its relationship to the site geologic structure;
- A description of any crustal tilting, subsidence, karst terrain, land sliding, and erosion;
- A description of the surface and subsurface geologic characteristics of the site and its vicinity;
- A description of the geomorphology of the site;
- A description of the location, attitude, and geometry of all known or inferred faults in the site and vicinity;
- A discussion of the nature and rates of deformation;
- A description of any man-made geologic features such as mines or quarries;
- A description of the seismicity of the site and region; and
- A complete list of all historical earthquakes that have a magnitude of 3 or more.

**f. Surface water hydrology**

- A description of site drainage and surrounding watershed fluvial features;
- Water resource data including maps, hydrographs, and stream records;
- Topographic maps of the site that show natural drainages and man-made features;
- A description of the surface water bodies at the site and surrounding areas;
- A description of existing and proposed water control structures and diversions (both upstream and downstream that may influence the site);
- Flow-duration data that indicate minimum, maximum, and average historical observations for surface water bodies in the site areas;
- Aerial photography and maps of the site and adjacent drainage areas identifying features such as drainage areas, surface gradients, and areas of flooding;
- An inventory of all existing and proposed surface water users whose intakes could be adversely affected by migration of radionuclides from the site;
- Topographic and/or aerial photographs that delineate the 100-year floodplain at the site; and
- A description of any man-made changes to the surface water hydrologic system that may influence the potential for flooding at the site.

**g. Groundwater hydrology**

- A description of the saturated zone;
- Descriptions of monitoring wells;
- Physical parameters;
- A description of groundwater flow directions and velocities;
- A description of the unsaturated zone;
- Information on all monitor stations including location and depth;
- A description of physical parameters;
- A description of the numerical analyses techniques used to characterize the unsaturated and

saturated zones; and

- The distribution coefficients of the radionuclides of interest at the site.

#### **h. Natural resources**

- A description of the natural resources occurring at or near the site;
- A description of potable, agricultural, or industrial ground or surface waters;
- A description of economic, marginally economic, or sub economic known or identified natural resources as defined in national regulations; and
- Mineral, fuel, and hydrocarbon resources near and surrounding the site which, if exploited, would affect the licensee's or responsible party's dose estimates.

### **A-2 FACILITY DESCRIPTION AND SAFETY RELATED STRUCTURES, SYSTEMS AND COMPONENTS**

#### **a. Contaminated structures**

- A list or description of all structures at the facility where licensed activities occurred that contain residual radioactive material in excess of site background levels;
- A summary of the structures and locations at the facility that the licensee or responsible party has concluded have not been impacted by licensed operations and the rationale for the conclusion;
- A list or description of each room or work area within each of these structures;
- A summary of the background levels used during scoping or characterization surveys;
- A summary of the locations of contamination in each room or work area a summary of the radionuclides present at each location, the maximum and average radionuclide activities, and, if multiple radionuclides are present, the radionuclide ratios;
- The mode of contamination for each surface (i.e., whether the radioactive material is present only on the surface of the material or if it has penetrated the material); and
- The maximum and average radiation levels in each room or work area; and a scale drawing or map of the rooms or work areas showing the locations of radionuclide material contamination.

#### **b. Contaminated systems and equipment**

- A list or description and the location of all systems or equipment at the facility that contain residual radioactive material in excess of site background levels;
- A summary of the radionuclides present in each systems or on the equipment at each location, the maximum and average radionuclide activities, and, if multiple radionuclides are present, the radionuclide ratios;
- The maximum and average radiation levels at the surface of each piece of equipment; and
- A summary of the background levels used during scoping or characterization surveys; and, a scale drawing or map of the rooms or work areas showing the locations of the contaminated systems or equipment.

## I-3 RADIOACTIVE INVENTORY

### a. Surface soil contamination

- A list or description of all locations at the facility where surface soil contains residual radioactive material in excess of site background levels;
- A summary of the background levels used during scoping or characterization surveys;
- A summary of the radionuclides present at each location, the maximum and average;
- Radionuclide activities, and, if multiple radionuclides are present, the radionuclide ratios;
- The maximum and average radiation levels at each location; and
- A scale drawing or map of the site showing the locations of radionuclide material contamination in surface soil.

### b. Subsurface soil contamination

- A list or description of all locations at the facility where subsurface soil contains residual radioactive material in excess of site background levels;
- A summary of the background levels used during scoping or characterization surveys;
- A summary of the radionuclides present at each location, the maximum and average radionuclide activities, and, if multiple radionuclides are present, the radionuclide ratios;
- The depth of the subsurface soil contamination at each location; and
- A scale drawing or map of the site showing the locations of subsurface soil contamination.

### c. Surface water

- A list or description of all surface water bodies at the facility that contain residual radioactive material in excess of site background levels;
- A summary of the background levels used during scoping or characterization surveys; and
- A summary of the radionuclides present in each surface water body and the maximum and average radionuclide activities.

### d. Groundwater

- A summary of the aquifer(s) at the facility that contain residual radioactive material in excess of site background levels;
- A summary of the background levels used during scoping or characterization surveys; and
- A summary of the radionuclides present in each aquifer and the maximum and average radionuclide activities.

## I-4 OPERATIONAL HISTORY

### a. Licence number/status/authorized activities

- The radionuclides and maximum activities of radionuclides authorized and used under the current licence;
- The chemical forms of the radionuclides authorized and used under the current licence;
- A detailed description of how the radionuclides are currently being used at the site;
- The location(s) of use and storage of the various radionuclides authorized under current



licences;

- A scale drawing or map of the building or site and environment showing current the locations of radionuclide use at the site; and
- A list of amendments to the licence since the last licence renewal.

**b. Facility history**

- The radionuclides and maximum activities of radionuclides authorized and used under all previous licences;
- The chemical forms of the radionuclides authorized and used under all previous licences;
- A detailed description of how the radionuclides were used at the site;
- The location(s) of use and storage of the various radionuclides authorized under all previous licences; and
- A scale drawing or map of the site, facilities and environs showing previous locations of radionuclide use at the site.

**c. Previous decommissioning activities**

- A list or summary of areas at the site that were cleaned up/decommissioned in the past;
- A summary of the types, forms, activities and concentrations of radionuclides that were present in previously cleaned up areas;
- The activities that caused the areas to become contaminated;
- The procedures used to cleanup the areas and the disposition of radioactive material generated during the decommissioning;
- A summary of the results of the final radiological evaluation of the previously cleaned up area(s); and
- A scale drawing or map of the site, facilities and locations showing the locations of previous decommissioning activity.

**d. Spills**

- A summary of areas at the site where spills (or uncontrolled releases) of radioactive material occurred in the past;
- The types, forms, activities and concentrations of radionuclides involved in the spill or uncontrolled release; and
- A scale drawing or map of the site, facilities and environs showing the locations of spills.

**e. Prior on-site burials**

- A summary of areas at the site where radioactive material has been buried in the past;
- The types, forms, activities and concentrations of waste and radionuclides in the former burial; and
- A scale drawing or map of the site, facilities and environment showing the locations of former burials.

## I-5 DECOMMISSIONING ACTIVITIES

### a. Contaminated structures

- A summary of the decommissioning tasks proposed for each room or area in the contaminated structure in the order in which they will occur;
- A description of the decommissioning techniques that will be employed in each room or area of the contaminated structure;
- A summary of the radiation protection methods and control procedures that will be employed in each room or area;
- A summary of the procedures already authorized under the existing licence and those for which approval is being requested in the decommissioning plan;
- A commitment to conduct decommissioning activities in accordance with written, approved procedures;
- A summary of any unique safety or decommissioning issues associated with decommissioning the room or area; and
- A summary of how the licensee will ensure that the risks addressed in the facility's safety analysis will be addressed during decommissioning.

### b. Contaminated systems

- A summary of the decommissioning tasks proposed for each system in the order in which they will occur including which activities will be conducted by licensee staff and which will be performed by a contractor;
- A description of the techniques that will be employed to decommission each system in the facility or site;
- A description of the radiation protection methods and control procedures that will be employed while decommissioning each system;
- A summary of the equipment will be removed or decontaminated and how the decontamination will be accomplished;
- A summary of the procedures already authorized under the existing licence and those for which approval is being requested in the decommissioning plan;
- A commitment to conduct decommissioning activities in accordance with written, approved procedures;
- A summary of any unique safety or decommissioning issues associated with decommissioning any system or piece of equipment; and
- A summary of how the licensee will ensure that the risks addressed in the facility's safety analysis will be addressed during decommissioning.

### c. Soil

- A summary of the removal/decommissioning tasks proposed for surface and subsurface soil at the site in the order in which they will occur including which activities will be conducted by licensee staff and which will be performed by a contractor;
- A description the techniques that will be employed to remove or cleanup surface and subsurface soil at the site;
- A description of the radiation protection methods and control procedures that will be

employed during soil removal/decommissioning;

- A summary of the procedures already authorized under the existing licence and those for which approval is being requested in the decommissioning plan;
- A commitment to conduct decommissioning activities in accordance with written, approved procedures;
- A summary of any unique safety or removal/decommissioning issues associated with cleanup the soil; and
- A summary of how the licensee will ensure that the risks addressed in the facility's safety analysis will be addressed during decommissioning.

**d. Surface and groundwater**

- A summary of the decommissioning tasks proposed for ground and surface water in the order in which they will occur, including which activities will be conducted by licensee staff and which will be performed by a contractor;
- A description of the decommissioning techniques that will be employed to cleanup the ground or surface water;
- A description of the radiation protection methods and control procedures that will be employed during ground or surface water cleanup;
- A summary of the procedures already authorized under the existing licence and those for which approval is being requested in the decommissioning plan;
- A commitment to conduct decommissioning activities in accordance with written, approved procedures; and
- A summary of any unique safety or decommissioning issues associated with cleanup the ground or surface water.

**e. Schedules**

- A Gantt or PERT (or other relevant) chart detailing the proposed decommissioning tasks in the order in which they will occur;
- A statement acknowledging that the dates in the schedule are contingent on Regulatory Body's approval of the decommissioning plan;
- A statement acknowledging that circumstances can change during decommissioning, and, if the licensee determines that the decommissioning cannot be completed as outlined in the schedule, the licensee or responsible party will provide an updated schedule to the Regulatory Body; and
- If the decommissioning is not expected to be completed within the timeframes outlined in the national regulations, a request for alternative schedule for completing the decommissioning.



## Appendix II

### EXAMPLE OF SAFETY CRITERIA RELEVANT TO SAFETY ASSESSMENT

- I-1 Dose and dose assessment criteria
  - Effective doses to and organ doses of workers;
  - Optimization of protection and safety;
  - Dose conversion factors, transfer factors; and
  - Effective doses to and organ doses of the public and optimization of protection and safety.
  
- II-2 Radiological risk criteria
  - Nature and magnitude of potential exposures and the likelihood of their occurrence;
  - Risk criteria (consequence and frequency) against which the acceptability of the safety assessment can be judged; and
  - Criticality criteria.
  
- II -3 Environmental limits (e.g. discharges from planned releases)
- II -4 Criteria for radiological categorization (e.g. areas of facilities)
- II -5 Design and engineering principles and standards to support the decommissioning activity
- II -6 Modelling criteria
- II -7 Waste processing, handling and transport criteria
- II -8 Waste acceptance criteria for storage and disposal
- II -9 Clearance and site release criteria, which can vary from country to country
- II -10 Limits on exposure to non-radiological hazards
- II -11 Occupational safety and health criteria
- II -12 Record-keeping criteria
- II -13 National policies and guidance relating to decommissioning and radioactive waste management.



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