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- A S A M -

The International Project on APPLICATION OF SAFETY ASSESSMENT METHODOLOGIES FOR NEAR SURFACE RADIOACTIVE WASTE DISPOSAL FACILITIES:

Scope, Objectives, Content and Work Programme

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-ASAM-

The International Project on APPLICATION OF SAFETY ASSESSMENT METHODOLOGIES FOR NEAR SURFACE RADIOACTIVE WASTE DISPOSAL FACILITIES

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EXECUTIVE SUMMARY

The safety of radioactive waste disposal facilities can be evaluated by using safety assessment methodology. In this context safety assessment means evaluation of the actual and potential hazards to human health and the environment associated with the natural evolution of a radioactive waste disposal facility over time, and with events, both deliberate and accidental, which could affect its integrity. By means of such analysis it is possible to identify the strengths and weaknesses in the overall safety of such facilities and as necessary to develop actions to improve their status.

The International Atomic Energy Agency's (IAEA) coordinated research project (CRP) "Improving Long Term Safety Assessment Methodologies for Near Surface Radioactive Waste Disposal Facilities" (ISAM) was launched in 1997 and completed in the year 2000. The main outcome of the project was the development of a harmonised methodology for carrying out post-closure safety assessment of near surface disposal facilities that can be applied iteratively to provide for the various purposes required of such safety assessment. The methodology has since found widespread acceptance and is being published in a series of reports dealing with scenario development, modelling and confidence building, together with three documented test cases for vault, borehole and Radon-type disposal facilities. Upon completion of the ISAM project it was recognised that a need existed to investigate further application of the ISAM methodology to a range of practical issues.

As a consequence, the IAEA is organizing a new and complementary CRP "Application of Safety Assessment Methodologies for Near-Surface Radioactive Waste Disposal Facilities" (ASAM). It will build on the experience gained with the ISAM programme, with special emphasis on application of the ISAM methodology to practical problems of topical interest with the prime objective to:

- explore practical application of the ISAM methodology to a range of near surface disposal facilities for a number of purposes, such as development of design concepts, safety reassessment and upgrading of existing facilities; and
- develop practical approaches to assist regulators, operators and other specialists reviewing safety assessments.

The emphasis of the ASAM project will be on evaluating the post-closure safety of radioactive waste disposal facilities, although, where considered appropriate, operational safety might also be assessed.

Initially the ASAM project will focus on the analysis of issues related to the safety of near surface disposal facilities, namely:

- assessing the safety of existing disposal facilities and facilities built to safety standards different from current standards;
- the disposal of disused sealed sources and other heterogeneous waste in near surface disposal facilities; and
- the disposal of mining and minerals processing waste and other waste with an enhanced content of naturally occurring radionuclides.

The project will also address:

- review of safety assessments and associated regulatory aspects; and
- important common issues in the application of safety assessment methodologies to different facility types such as the assessment of disruptive events (e.g. human intrusion) and the performance of engineered barriers.

It is envisaged that the main outcomes of the project will be improvement and harmonisation in the way that safety assessment methodology is applied in practice, development of a coherent and consistent approach to the treatment of a number of common issues and the development of consensus on approaches to regulatory review of safety assessments and the associated decision making processes.

Participants in the CRP should be from organizations or regulatory bodies concerned with assessing and improving the safety of near surface disposal facilities in their own countries. They will be expected to contribute to the project by participating in technical discussions, applying methodologies to real problems and taking part in the development of test cases. The participants will benefit from the exchange of information with experts from different countries facing similar problems on safety of near surface disposal facilities.

CONTENT

1. INTRODUCTION

The International Atomic Energy Agency (IAEA) is a Specialist Agency within the United Nations family and amongst its main statutory functions are the establishment of safety standards for the protection of human health from the effects of ionising radiation [1], and to provide for the application of the standards. In discharging these functions, the IAEA has established a framework [1, 2] of internationally agreed standards on nuclear safety, radiation protection, transport and radioactive waste safety and a number of mechanisms for their application, such as peer reviews, technical assistance, exchange of scientific and technical information on peaceful use of atomic energy, training and research and development. Coordinated Research Projects (CRPs) are one of the useful mechanisms for exploring the safe use of atomic energy and for improving the safety of radioactive waste management. This includes research projects on the safety of radioactive waste disposal [3, 4] and in particular, on long-term safety assessment methodologies for low and intermediate level radioactive waste disposal facilities.

2. BACKGROUND

Safety assessment is a process, which is used to evaluate the safety of radioactive waste disposal facilities. Such assessments, which are iterative in nature, evaluate the potential impact that such facilities could have on human health and the environment as a function of time in the future.

It is important that safety assessments are carried out in a traceable, transparent and consistent way in order to provide an assurance to stakeholders (such as governments, regulatory authorities, the general public and technical/scientific personnel) that the facility has been or will be sited, designed, constructed, operated and closed in such a manner that will provide a high level of assurance that human health and the environment is protected over the necessary long timescales.

Safety assessment is an important component in evaluating the acceptability of a radioactive waste disposal practice and plays a key role in the development of a safety case[1] for the life cycle of the radioactive waste disposal facility (Figure 1).

The IAEA's coordinated research project "Improving Long Term Safety Assessment Methodologies for Near Surface Radioactive Waste Disposal Facilities" (ISAM) was launched in 1997 and completed in the year 2000 [5]. It provided an evaluation of the approaches and tools used in long-term safety assessment of near surface disposal facilities, enhanced the approaches used, provided participants with practical experience in the implementation of the approaches, and contributed to the building of confidence in the approaches used in Member States. Three specific areas of methodological interest were defined: scenario generation and justification, model formulation and implementation, and confidence building [6].

[1] A safety case is a collection of arguments and evidence to demonstrate the safety of a facility or activity. This will normally include a safety assessment, but would also typically include information (including supporting evidence and reasoning) on the robustness and reliability of the safety assessment and the assumptions made therein [10]

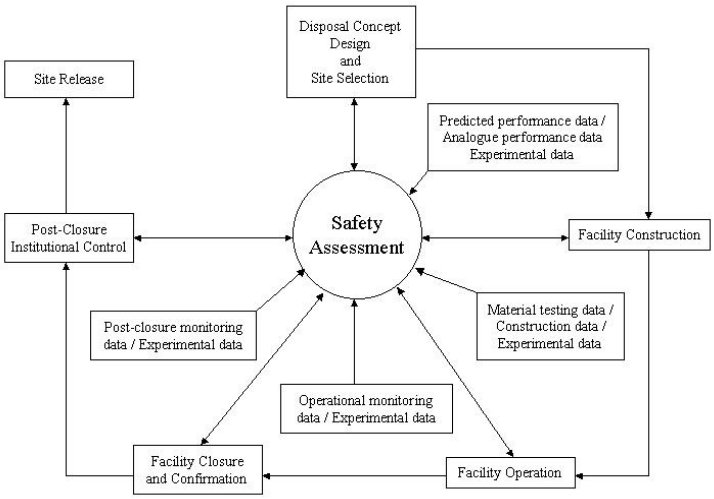

Fig. 1 Application of Safety Assessment during the Development of a Radioactive Waste Disposal Facility

As part of the ISAM project, a consistent safety assessment methodology was developed (the ISAM safety assessment methodology) which has the following key components (Figure 2):

(a) specification of the assessment context;

(b) description of the radioactive waste disposal system;

(c) development and justification of scenarios;

(d) formulation and implementation of conceptual and mathematical models; and

(e) analysis of results and building of confidence.

Each of these components is discussed in Appendix A.

Preliminary application of the ISAM safety assessment methodology was illustrated as part of the ISAM project using three example test cases – a vault type facility, a borehole type facility (a design concept under development for disposal of disused sealed sources) and a RADON-type facility (a particular range of disposal facility designs developed within the former Soviet Union) [7].

The ISAM project provided a forum for the exchange of information and good practices on safety assessment methodologies used worldwide. It provided an opportunity for reaching broad consensus on the methodologies used to perform safety assessments for near surface disposal facilities. The ISAM methodology has found widespread acceptance, although, at the end of the ISAM project, it was recognised that the need existed to investigate further application of the ISAM methodology to a range of practical issues. This need related specifically to areas such as the depth and quality of safety assessment, the treatment of human intrusion, confidence building in safety assessment and the overall safety case. Activities that were identified to be of particular interest were licensing, upgrading, re-evaluation of safety of near surface radioactive waste disposal facilities of different type (vault, Radon, mining and mill tailings, etc.)

Taking this into consideration, the IAEA has prepared a new CRP "Application of Safety Assessment Methodologies for Near-Surface Radioactive Waste Disposal Facilities" (ASAM), which is now being implemented. It will build on the experience of the ISAM project, with special emphasis on the application of the ISAM methodology to address practical problems of interest.

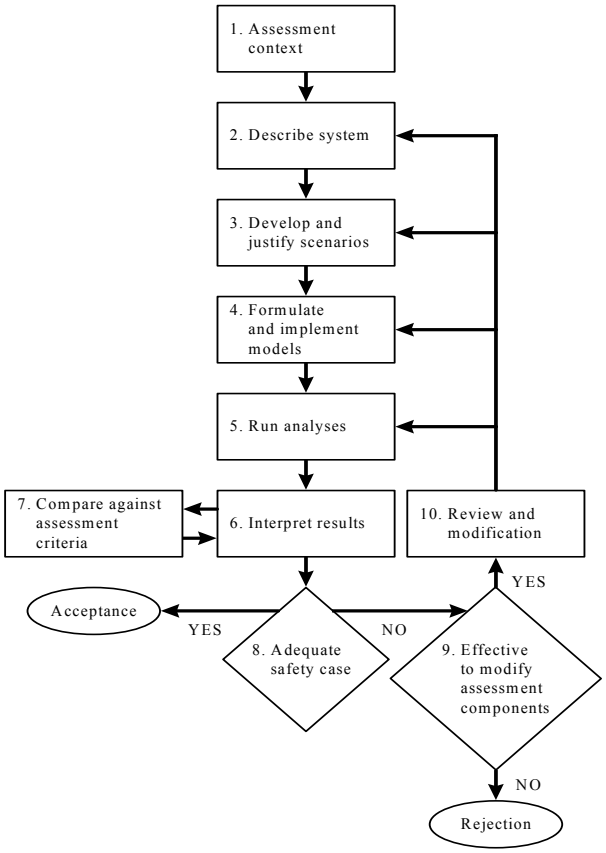

Fig. 2. The ISAM Safety Assessment Methodology

3. OBJECTIVES OF THE ASAM PROJECT

The overall objectives of the ASAM project are:

(a) explore practical application of the ISAM methodology to a range of near surface disposal facilities for a number of purposes, such as development of design concepts, safety reassessment and upgrading of existing facilities; and

(b) develop practical approaches to assist regulators, operators and other specialists reviewing safety assessments.

4. SCOPE OF THE ASAM PROJECT

The ASAM project will consider practical application of the ISAM safety assessment methodology to proposed and existing near surface radioactive waste disposal facilities, i.e. disposal facilities at or close to the Earth's surface (e.g. vault type facilities or mine and mill tailings) and disposal facilities at depths of up to several tens of meters (e.g. boreholes, cavern facilities). The emphasis of the ASAM

project will be on post-closure safety assessment although, where considered appropriate, operational safety might also be assessed.

The inventories to be considered will include a range of low and intermediate level waste (but not high level waste) arising from: the extraction and processing of naturally occurring radioactive materials; the generation of nuclear power; the use of radionuclides in research, industry, medicine and education; and the decommissioning of nuclear facilities. The primary focus will be on the radioactive contaminants in the associated waste streams, however, where considered appropriate non-radioactive contaminants will also be assessed. The ISAM safety assessment methodology will be applied to real disposal facilities with the aim of producing credible safety assessments for realistic situations. This approach will ensure that the focus of the project remains on credible solutions to safety assessment issues that can be used in practical decision-making.

5. CONTENT OF THE ASAM PROJECT

5.1. RESEARCH COORDINATION MEETINGS

There will be a number of research coordination meetings (RCMs) during the ASAM project, which will be organised and hosted by the IAEA (see Section 6.2). These meetings will have a pivotal role in discussing, and agreeing the focus, direction and outcomes of the ASAM project. At the first RCM, proposals for the work plan to be undertaken will be discussed and agreed. Subsequent meetings will review progress with the various working group activities and agree the way forward and any necessary adjustments to the project. The final meeting will review the outcome of the project and its documentation.

The meetings will also provide ASAM participants with the opportunity to exchange knowledge, experience and information on a range of issues relating to safety assessment through topical presentation sessions either oral or by posters.

5.2. WORKING GROUP ACTIVITIES

It is proposed that the work plan for the ASAM project will be discussed and agreed at the RCMs. It is envisaged that it will be implemented through five working groups to be developed (see Section 6.1).

Three working groups (referred to as Application Working Groups) will be associated with development of practical application cases based on real sites and will focus on:

(a) reassessment of the safety of existing disposal facilities (Safety Reassessment Working Group);

(b) the disposal of disused sealed sources and other heterogeneous radioactive waste (Disused Sealed Sources and Heterogeneous Waste Working Group); and

(c) disposal of mining and minerals processing waste and other waste with an enhanced content of naturally occurring radionuclides (Mining and Minerals Processing Waste Working Group).

The two additional Working Groups (referred to as Cross-cutting Working Groups) will be associated with issues that cut across the three Application Working Groups, namely:

- review and associated regulatory aspects, including the development of recommendations for the regulatory review of a safety assessment; incorporation of safety assessment in a safety case, and review of safety case (Review and Regulatory Aspects Working Group); and
- specific common aspects in application of safety assessment methodologies such as the assessment of disruptive events (e.g. human intrusion) and the performance of engineered barriers (Common Application Aspects Working Group).

The rationale, proposed scope and anticipated outcomes of each of these working groups are outlined in the following sub-sections. It should be noted that the ideas given below are initial ideas that will be developed and finalised in light of discussions at the first RCM. In particular, account will be taken of the level of interest and willingness to participate actively in the working groups and their proposed activities. Care will be taken to ensure that the level of ambition of the ASAM project is set consistent with the resources available. The lists of activities within each working group given below are not definitive, alternative/additional activities could be considered if there is the interest expressed by the participants at the first RCM. It is intended that a document providing a more detailed technical description of the proposed working group activities will be discussed and finalised at the first RCM.

5.2.1. Reassessment of Safety of Existing Disposal Facilities

- ***Rationale***

A large number of near-surface disposal facilities exist, either in operation or closed, for which safety assessments have been conducted at varying levels of completeness and quality. For some facilities safety assessments have recently been conducted that are up to current standards, yet on-going reassessments of safety are needed as part of routine regulatory programmes or because of revisions to the operating conditions that have been proposed since licensing or the previous licence review. Other, often older, facilities may have had assessments conducted that are no longer considered adequate by present day standards. Furthermore, at some of these facilities, disposal practices have been conducted that may not meet modern concepts of safety, and consideration must be given to corrective measures.

The basis for making decisions in many of these cases is unclear, and it is not possible to clearly categorise them as a justified practice or a clear case for intervention. Such sites may be appropriate for continued use as a justifiable practice, or they may require corrective actions/intervention (for instance to remove problem

radioactive waste types/forms), after which they may be appropriate for continued use as a justified practice. It is intended that the working group should address the role of safety assessment in these situations. A proposed decision flow chart is shown in Figure 3, illustrating the decisions that may be needed.

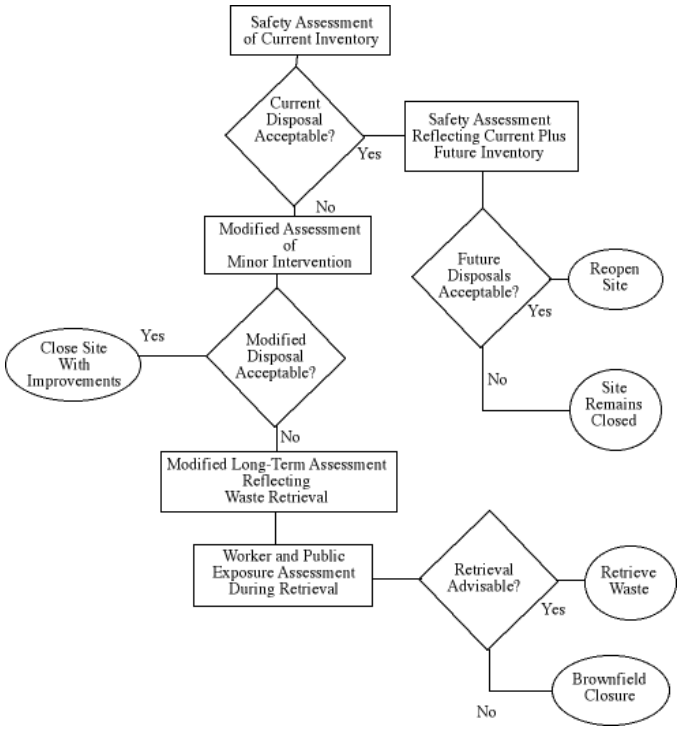

Fig. 3. Proposed Decision Flowchart for Mixed Practice-Intervention Situations [8]

- ***Scope***

This working group will investigate application of the ISAM safety assessment methodology to operating radioactive waste disposal facilities, where:

(a) the safety of the existing facility has not yet been demonstrated;

(b) no safety assessment has been performed;

(c) safety of the facility has been questioned because revisions to the operating conditions have been proposed; or

(d) a periodic review and update of the safety assessment is required by the regulator.

Comparison of different corrective action options will be made with the aim of assisting decisions for future development of these types of facilities. The same approach would be appropriate for radioactive waste storage facilities under consideration for conversion to disposal facilities.

As an initial effort, it is proposed that the working group should consider an existing real disposal facility. A suitable facility has been identified and the operators of the facility have volunteered to make pertinent data available to the ASAM project to test the ISAM safety assessment methodology. Currently, initial safety assessments

have been conducted that show that there is negligible current public risk associated with the site; however, long-term safety assessments suggest that potential doses in the future may not meet currently acceptable dose constraints. Consequently, current attention is placed on evaluating the necessity of remedial actions, and on decision-making associated with various possible alternatives.

Depending on the interest of the participants and the availability of a volunteer site, a second problem may be considered the re-evaluation of a licence for an operating site that has recently been through a thorough, modern safety assessment. The purpose would be to investigate the use of safety assessment in the context of a periodic licence review and would provide the opportunity to apply the regulatory review procedure developed by the Review and Regulatory Aspects Working Group (see Section 5.2.4).

The working group may consider other problems, within the constraints of available resources, the willingness of the site to volunteer, and the appropriateness of the site for the working group as a whole.

- ***Objectives***

The purpose of this working group is to address the reassessment of safety of existing operational radioactive waste disposal facilities. The work of the group will be focused on:

(a) systematic application of the ISAM safety assessment methodology for assisting decisions in the selection of alternatives for corrective actions;

(b) development of an approach to evaluate the balancing of potential future radiological risks and current radiological and non-radiological risks (e.g. cost, worker risks, environmental risks) for interventions; and

(c) providing advice to facilitate decision-making on correction of past practices, and to justify corrective actions/intervention.

- ***Outcomes***

The activities of the working group will form a bridge between the technical approaches used in implementation of corrective actions/interventions and those used in safety assessments of radioactive waste disposal practices. It is anticipated that they will also:

(a) provide a practical demonstration of the ISAM safety assessment methodology to address this real problem;

(b) support the review and judgement of the acceptability of differing options by providing a quantitative comparison of the different options; and

(c) support decision-making in the selection of alternatives for corrective actions.

5.2.2. Safety Assessment of Facilities for Disposal of Mining and Minerals Processing Waste and Other Waste with an Enhanced Content of Naturally Occurring Radionuclides

- **Rationale**

Radioactive waste generated by mining and minerals processing and other waste with an enhanced content of naturally occurring radionuclides differs in some respects from that generated at nuclear power plants, medical facilities, research centres and other industrial applications of radiation sources. Such waste contains relatively low concentrations of radioactivity, but is generated in large volumes compared to those from other sources of radioactive waste. This waste poses unique potential of environmental and public health risks due to the long-lived radionuclides that are contained in the waste and due to very large volumes of material that must be controlled.

Releases to the environment from mining and minerals processing waste disposal facilities give rise to possible sources of radiation exposure to humans and the environment. The management methods employed for these types of waste are also different and usually involve disposal on or near the surface in the vicinity of the mine and/or mineral processing facilities. The long-term safety assessment methodology developed under the ISAM programme has not been extensively applied to these types of near-surface disposal facilities to explore their long-term safety. The practical application of the methodology to these facilities will provide a useful tool for management and will assist in decision-making for their long-term safety.

- ***Scope***

Consideration will firstly be given to the application of the ISAM safety assessment methodology to an existing disposal facility for mining and minerals processing waste; indications are that such a facility will be volunteered for the purpose.

The hazards to humans and the environment from mining and milling waste arise from both its radioactive nature and from other toxic materials contained in the waste. Although achieving a consistent regulatory approach for protection against these different hazards is important, the working group will address both risks with main focus on the radiological hazards associated with this waste.

The scope of the work of the working group is limited to assessing the long-term effect of a facility and consequently will focus on the application of the ISAM safety assessment methodology to the post-closure period of the facility. However, it is recognised that interdependencies exist between these two periods and these will be considered.

Consideration might also be given to the application of the ISAM safety assessment methodology to other waste with enhanced concentrations of natural radionuclides; however, this will be dependent on the level of interest displayed and also on the availability of a volunteer site.

- ***Objectives***

The activity of this working group will:

(a) investigate the application of the ISAM methodology to near-surface disposal facilities for mining and minerals processing waste and other waste with enhanced content of naturally occurring radionuclides with the purpose of exploring the issues affecting their long-term safety;

(b) identify features, events and processes (FEPs) specific to facilities for disposal of mining and minerals processing waste and other waste with enhanced content of naturally occurring radionuclides; and

(c) assess the applicability/suitability of the regulatory review procedure, developed by the Review and Regulatory Aspects Working Group (see Section 5.2.4) to the assessment of a disposal facility for mining and minerals processing waste.

- ***Outcomes***

It is anticipated that the activities of this working group will:

(a) demonstrate the applicability of the ISAM safety assessment methodology to evaluate the long-term safety of near-surface disposal facilities for mining and minerals processing waste and possibly other waste with enhanced concentrations of natural radionuclides. This will include consideration of a sufficiently wide range of future behaviours and states of the disposal system; and

(b) develop a list of FEPs that could directly or indirectly influence the disposal system applicable to these types of waste and associated disposal facilities. The resultant list of FEPs will be added to the existing ISAM FEPs list for near surface waste disposal facilities.

A further outcome could be the practical application of the regulatory review procedure developed by the Review and Regulatory Aspects Working Group to the review of the safety assessment of mining and minerals processing waste and other waste with an enhanced content of naturally occurring radionuclides.

5.2.3. Safety Assessment of Disposal of Disused Sealed Sources and Other Heterogeneous Waste

- ***Rationale***

A wide variety of radioactive waste can be disposed in near surface facilities. This can include technological waste (safety equipment, materials for laboratory work, metal and plastic parts, water filters and ventilation circuits filters), process/operational waste (e.g. concentrates, sludge, bitumen, ion exchange resins, filters), and decommissioning waste (e.g. obsolete equipment and machines, spent glove boxes, concrete and structural materials, glass wool, graphite sleeves from gas-cooled reactors). In many countries disused sealed sources also represent a part of the radioactive waste inventory for which a disposal solution has to be found. Medical

applications, industry, laboratories, as well as nuclear facilities produce these sources. They are sometimes identified in very small quantities and with very specific characteristics in the case of small producers, or in larger streams with standard characteristics in others.

This wide variety of waste induces three different levels of waste heterogeneity: (i) hot spot (e.g. disused sealed sources); (ii) large item inside a package (e.g. metal components); and (iii) very large items to be disposed of directly in the disposal unit (e.g. irradiated pipes, vessels). Safety assessments generally assume a certain level of waste homogeneity in most of the existing or proposed disposal facilities. There is a need to evaluate the appropriateness of such an assumption and the influence on the results of safety assessment.

This need is especially acute in the case of sealed sources. Disposal in near surface disposal facilities has been and continues to be used for some disused sealed sources. However, the disposal facilities and the associated regulatory approaches are variable. In some countries large quantities of disused sealed sources have been disposed of with limited restriction, in others, their disposal in near surface facilities is forbidden. In all cases evaluation of the acceptability of disposing disused sealed sources in near surface disposal facilities is of utmost importance.

- ***Scope***

The working group will consider the broad variety of heterogeneous waste and conditioning techniques generating heterogeneous waste packages identified by participants. Primary attention will be focussed on sealed sources. At present, the extent to which the working group will need to focus on one or more specific sites has still to be determined. A real volunteer site has yet to be identified. However, it is considered that appropriate progress can be made within the working group through the assessment of realistic (rather than real) sites. Certainly it is anticipated that the approach will cover, at least, all the existing or proposed options such as vault and borehole type facilities, but also other possible options such as loose tipping in a trench.

It is proposed that both the operational and post-closure phases of the near-surface disposal facility to be studied will be addressed.

- ***Objectives***

The objective of this working group is to study the applicability of the ISAM safety assessment methodology in order to evaluate the safety implications and acceptability of disposing heterogeneous waste, in particular disused sealed sources, in near surface disposal facilities. It is proposed that the working group proceeds firstly with the assessment of disused sealed sources.

For this step, the specific objectives are:

(a) to take into account the large variety of sealed sources, in terms of radiological characteristics (e.g. half-life, activity, dose rate), mechanical characteristics (e.g. fabrication, tightness, envelop, size), and total inventory;

(b) to assist in evaluating the safety of existing disposal facilities containing disused sealed sources conditioned using different techniques;

(c) to assist in the evaluation of different possible concepts proposed for the disposal of disused sealed sources; and

(d) to derive waste acceptance criteria (e.g. reference activity limits) for different disposal concepts and to complement the work undertaken by the IAEA on derivation of activity limits for disposal of radioactive waste to near surface facilities [9].

Depending on the interest and resources available, it is proposed that the working group could extend the focus of its work to include other heterogeneous waste (e.g. large items in waste package).

- ***Outcomes***

The study will demonstrate the application of the ISAM Safety Assessment Methodology to the assessment of near surface disposal of disused sealed sources and potentially other heterogeneous waste. It will also lead to:

(a) the proposed classification of identified heterogeneous waste with regard to their radiological impact;

(b) identification of the additional radiological risks associated with such heterogeneous waste to be taken in comparison to other waste;

(c) the generation of relevant scenarios (and conceptual and mathematical models) associated with such heterogeneous waste; and

(d) the derivation of reference activity levels for the disposal of such heterogeneous waste.

5.2.4. Review and Associated Regulatory Aspects

- **Rationale**

Forming a judgement about the safety of a radioactive waste disposal facility involves assessment of the means by which radionuclides in the waste might migrate from the waste through the immediate physical and chemical environment of the facility to the environment and evaluation of the consequent radiological impact. This will entail consideration of the potential behaviour of radionuclides over extended periods of time. The safety case provided by the developer or operator in support of an application for authorisation will normally have to address all these issues, in addition to demonstrating that the disposal facility is appropriately sited and well designed including a demonstration that the principle of defence in depth principle has been applied. The regulatory authority will need to be satisfied that good engineering practice has been used in developing proposals for design, and that the facility will be constructed, operated, and closed in accordance with the design. The safety case will have to provide a high level of confidence that good science has been applied in investigating the suitability of the site, in supporting research and

development work, in the interpretation of the resulting data and the safety assessment methodologies used.

International safety standards require safety review of licensed radioactive waste disposal facilities and in many cases the regulatory authorities require this in order to:

(a) grant authorisation for the construction, operation or closure of the facility;

(b) evaluate the current status of disposal facilities and make comparison with the previous safety cases, in some cases with the purpose of upgrading the safety;

(c) update the safety case in compliance with the latest safety requirements, incorporating state of the art safety assessment methodologies, modelling and computer codes; and

(d) evaluate the impact of natural and human induced changes which could affect the safety of a radioactive waste disposal system (e.g. change to the waste inventory physico-chemical properties of the engineered barriers, geology, water table, biosphere, etc.).

- ***Scope***

The working group will focus its activities on the process of regulatory review of safety assessment of near surface low and intermediate level radioactive waste disposal facilities, including those for disposal of mining and minerals processing waste and other waste with enhanced concentrations of natural radionuclides.

The group will consider undertaking three important activities:

(a) the development of a procedure for regulatory review of a post-closure safety assessment of a near surface disposal facility;

(b) the development of structure and content of a safety case and the integration of the post-closure safety assessment within it, together with regulatory review of the safety case; and

(c) the identification of mechanisms and strategies to build confidence in the post-closure safety assessment and the safety case for near surface waste disposal facilities.

It is proposed that each Application Working Group uses the systematic approach developed for review of safety assessment for a near surface waste disposal facility. This should provide advice to the Review and Regulatory Aspects Working Group on the safety related aspects to be considered, their prioritisation according to their importance, the international regulations and recommendations pertinent to specific technical matters to be taken into account. A harmonised review procedure will be developed with this regard.

The working group will first concentrate on the development and illustration of a regulatory review procedure. Once this activity has been completed, and taking into account the availability of time and resources, the group will continue implementing the planned activities up to the end of the project.

- ***Objectives***

The main objective of the working group is to develop systematic procedures for the review of post-closure safety assessments for near surface waste disposal facilities that will assist regulators, safety assessors, operators, and independent reviewers in:

(a) decision making on the adequacy and acceptability of a safety case;

(b) decisions on future options proposed for development of a disposal facility; and

(c) identifying and resolving safety issues and changes at a disposal facility.

As second objectives, and depending on time and resources available, the working group will develop guidance on integration of the safety assessment into the safety case, and on the review of safety case for near surface disposal facilities and will identify and document strategies for improving stakeholders' confidence in the post-closure safety assessment and in the associated safety case.

- ***Outcomes***

(a) Regulatory review procedures will be produced that will provide guidance to Regulatory Authorities, safety assessors, operators, and independent reviewers in making decisions on the acceptability of post-closure safety assessments and safety cases of near surface disposal facilities; and

(b) A document describing the findings from the practical application of this regulatory review procedure within the ASAM project.

In addition, if the second objective of the working group is fulfilled (see above), guidance documents will be provided on:

- integration of the safety assessment into the safety case;
- review of safety case; and
- strategies for improving stakeholder confidence in the post-closure safety assessment and the associated safety case.

5.2.5. Common Aspects in Application of Safety Assessment Methodologies

During the ASAM project, it is anticipated that certain issues of common concern to all three Application Working Groups will be identified relating to the practical application of the ISAM safety assessment methodology. It is proposed that these, together with the additional topics identified below, will be considered by the Common Application Aspects Working Group with the aim of providing practical guidance on the treatment of these issues, within the Application Working Groups.

It is envisaged that the working group will adopt the following approach. At the first RCM, the list of topics identified below will be reviewed, together with any further suggestions made by the participants. Depending on the level of interest and willingness to participate actively in the resolution of each topic, the priority topics to be initially addressed by the working group will be discussed and agreed at the first

RCM . Care will be taken to ensure that the level of ambition of the working group is set consistent with the resources available. Participants who will be willing to develop ideas for the resolution of each issue will be identified and, following the first RCM, they will develop a preliminary position paper for discussion at the first working groups meeting. Where possible, practical examples of good practice in the treatment of the issue will be presented in the position paper. Following discussion at the meeting and the provision of review comments from the wider set of ASAM participants, the position paper will be revised and practical guidance provided for the treatment of the issue. This process of drafting, review and revision will continue until a draft final document has been produced for each issue. The resulting draft guidance will aim at application by the Application Working Groups and any results from its practical use will be taken into account in the finalisation of the guidance. A similar approach will be adopted for any additional issues that are identified by the Application Working Groups during the ASAM project.

Potential topics for consideration include the following:

(a) The assessment of **disruptive events** (such as human intrusion and fluvial erosion) at a radioactive waste disposal facility. Such events could be one of the principal mechanisms leading to the exposure of humans for a near surface disposal facility. The current approaches used to assess disruptive events that might affect near surface disposal facilities will be reviewed and, if possible, a consensus approach proposed for the assessment of these events in long-term safety evaluation;

(b) The assessment of **engineered barrier performance**. Identification of safety relevant features of the engineered components of a disposal facility and evaluation of their safety function/performance (effectiveness, longevity, failure mechanisms) is a key part of the safety assessment methodology. However, often only qualitatively estimates of the long-term performance of such barriers can be provided for use in a safety assessment. The assumptions made relating to the long-term performance of engineered barriers, their justification and their integration into previous safety assessments will be reviewed. Recommendations will be made for the modelling of the long-term performance of engineered barriers.

(c) **Heterogeneities in the near field**. Safety assessments often assume that the near-field is homogeneous not only in terms of the waste characteristics (see Section 5.2.3), but also in the distribution of waste in the disposal facility, the physical and chemical characteristics of the near-field, and their degradation with time. However, in reality, there can be significant heterogeneities that might need to be accounted for in the safety assessment, for example in the assessment of human intrusion. The current approaches used in safety assessments to consider heterogeneities in the near field (excluding waste heterogeneities) will be reviewed and recommendations made. Care will be taken to ensure consistency with the work undertaken on heterogeneity within the Disused Sealed Source and Heterogeneous Waste Working Group, which will focus on the heterogeneity of radioactive waste.

(d) **Safety assessment priorities**. Many safety assessment methodologies are iterative. Once the first pass through the methodology has been undertaken,

there might be a number of issues that need to be address in the second pass through, for example the development of additional scenarios, the collection of further data or the development of alternative conceptual and mathematical models. These issues need to be prioritised and it is proposed that the working group should develop guidance in this area.

(e) The **management of uncertainties** is an important component of any safety assessment methodology. Approaches for the selection and prioritisation of data necessary for the performance of safety assessment will be reviewed, together with approaches for the treatment of data and other forms of uncertainty (such as scenario and conceptual model).

As shown in Figure 1, safety assessment can be used to help in the **siting** processes for a near surface disposal facility. It is proposed to undertake a review of the application of safety assessment in the siting process and provide examples of siting programmes.

A further task for this working group will be to review the output from the three Application Working Groups and identify and recommend any necessary enhancements to the ISAM safety assessment methodology and supporting tools (such as the ISAM FEPs list) resulting from its practical application.

6. ORGANISATION, WORK PLAN AND OUTCOMES OF THE PROJECT

6.1. ORGANISATION

The organisation structure of ASAM is presented in Figure 4 and the main components are described below.

- **The Coordinating Group**

The ASAM Coordinating Group will consist of a Chairperson, the leaders of the five working groups and the IAEA Scientific Secretary. Its role will be to coordinate the activities of the individual working groups, identify and solve common issues of a technical and organisational nature that need to be resolved as part of the project, prepare and coordinate the topics, agendas and summaries of the RCMs and Working Groups meetings, and coordinate the preparation and review the ASAM documents and materials.

- **The IAEA Scientific Secretary**

The IAEA Scientific Secretary will provide coordination with the IAEA and technical and administrative assistance to the project. The Scientific secretary will also make the necessary arrangements for planning, conducting RCMs and other working group activities in accordance with the ASAM work plan, as well as for documentation of the proceedings of the meetings, working group activities and final outcomes of the project.

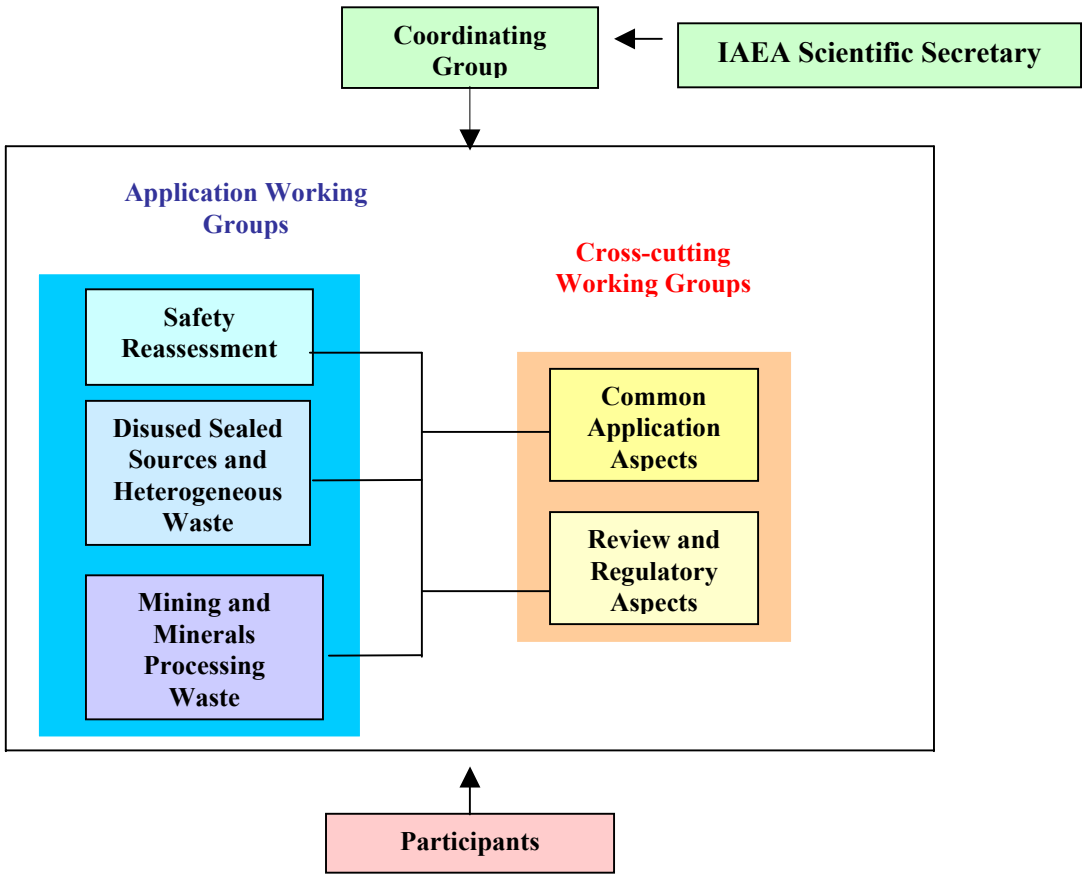

Fig. 4. Organisational Structure of the ASAM Project

- **Working Groups**

The working groups will prepare the material needed for the presentation, discussion, and documentation of the technical issues which will be addressed by the project; help organise the technical sessions of RCMs and Working Group meetings; and support the Coordinating Group as required in production and reviewing the ASAM documentation. Each working group will consist of a Working Group Leader and a number of participants who will actively contribute to the work undertaken by the working group.

- **Participants**

The ASAM project is open to professionals from Member State who undertake technical activities related to safety assessment of radioactive waste disposal facilities. Participants can be from regulatory bodies, facility operators or developers, technical support organizations or research organisations. They will be expected to contribute to the project by participating in technical discussions, applying methodologies to real problems and taking part in the development of test cases. Participants will be able to participate in one or more ASAM working groups (for example one of the Application Working Groups or one of the Cross-cutting Working Groups). In addition, they will have the opportunity during the RCM topical sessions to give oral or poster presentations describing the safety assessment related

work that they have undertaken within their own national programmes or related projects.

6.2 WORK PLAN

The main activities of the ASAM projects are as follows:

a) Meetings

Three main types of meetings are planned to be organised within the ASAM project:

- RCMs;
- Working Group (WG) meetings; and
- Coordinating Group (CG) meetings.

The tentative schedule of the meetings planned to take place during project is presented in Table 2. However, it is anticipated that additional WG meetings will be held to develop and document their work programme and associated findings.

Table 2. Tentative Schedule of ASAM Activities

Date	Activities
June 2002	Scope, Objectives, Content and Work Programme Document
September 2002	Coordinating Group (CG) meeting, Vienna, Austria
6-8 November 2002	Coordinating Group (CG) meeting, Vienna, Austria
	Initial Working Group Document
11-15 November 2002	1st RCM, Vienna, Austria
	Final Working Group Document
July 2003	Working Groups (WG) and CG meeting (draft WG documents)
February 2004	2nd RCM (draft WG documents)
July 2004	WGs and CG meeting (draft WG documents)
March 2005	WGs and CG meeting (draft WG documents)
November 2005	3rd RCM meeting; WG documents final drafts
2006	Final ASAM reports

b) Development of ASAM Documents and Materials

It is envisaged that several main groups of documents/materials will be produced during the ASAM project.

- An ***introductory document*** describing the scope, objective, content and work programme of ASAM (this document).
- A ***detailed document*** describing the proposed technical focus of each working group, which will be discussed and finalised at the first RCM.
- ***ASAM Newsletters*** reflecting the progress made by the individual working groups and a summarising the issues of interest of the ASAM participants. It will also provide useful information on the related IAEA activities in the field of safety assessment and radioactive waste management. The newsletters will be produced regularly on an as needed basis.

- ***Working Group documents*** will be produced by each working group as the ASAM project develops and will establish the basis for the final ASAM reports.
- ***Summary of each meeting***. A summary of the RCMs will be produced by the IAEA Scientific Secretary after each RCM and will include: a brief summary of main topics, conclusions and recommendations of the meeting, as well as information on the current status of the project and its future. The ASAM Chairperson and working group leaders will follow the same procedure after completion of Coordinating Group and each working group meeting.
- ***ASAM final technical reports*** summarising the work undertaken and results achieved and lessons learned during the project.
- ***ASAM CD-ROM*** including the final technical reports and other relevant supporting information presented, collected, developed or provided by the participants during the project.
- **ASAM website** will be provided and used to facilitate the coordination of the working groups activities, the individual participants access to the up-to-date ASAM documentation and additional useful IAEA and other information. The website will be part of the IAEA RasaNet website and will be developed for the use of the ASAM participants.

6.3 OUTCOMES

It is envisaged that the main outcomes of the project will be:

(a) improved mechanisms for application of long-term safety assessment methodologies for near surface disposal facilities through:

- illustration and practical advice on application of safety assessment methodologies using three important cases associated with the safety assessment of near surface radioactive waste disposal facilities;
- development of a coherent approach to addressing a number of common issues related to the safety assessment of these facilities;

(b) consensus on approaches to regulatory review of safety assessment of near surface radioactive waste disposal facilities and development of associated procedures, reflecting state-of-the-art international practice.

The project is expected to contribute to enhancement of the ISAM safety assessment methodology. It will also improve the knowledge of participants and provide technical input to the IAEA's RADWASS Programme through the consideration of a variety of issues relevant to safety assessment for near surface waste disposal facilities.

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APPENDIX A

Main Elements of the ISAM Methodology

A1. Assessment Context

Safety assessment of the post-closure phase of a radioactive waste disposal facility is generally undertaken to provide an assurance to stakeholders (such as government, regulatory authorities, the general public and technical/scientific personnel) that the facility has been or will be sited, designed, constructed, operated and closed in such a manner as to ensure protection of humans and the environment over long timescales. However, this generic objective does not provide a very precise description of what has to be considered in the assessment. During the development of a disposal facility, the safety assessment will also be developed, becoming more detailed and specific as the project progresses. At the early stages of a project, where a number of sites or a number of design options may be under consideration, a more general assessment may be undertaken with less detailed information on the exact waste inventory and form, the disposal facility design or site. Following selection of a site, much more detailed information will become available on the site and its characteristics and detailed design options will be considered. For existing sites the need may exist to update an already existing assessment or carry out a completely new assessment. As such the context in which the assessment is being carried out will significantly influence its structure, content and level of detail.

The safety assessment context is intended to clarify what is going to be assessed and why is it going to be assessed. In addressing the assessment context, information should be provided concerning the following key aspects that need to be considered at the start of the safety assessment. It should be noted that many components of the assessment context are inter-related, and decisions relating to one component can influence other components. For example, the end-points assessed should be appropriate for the timeframes considered in the assessment.

(a) Purpose

Most safety assessments of radioactive waste disposal facilities have the principal, objective to demonstrate that an acceptable level of protection of human health and the environment will be achieved both now and in the future. In addition to this overall demonstration of safety there can be a variety of additional purposes.

In any specific case, however, the purpose of conducting an assessment may vary from simple calculations to test initial ideas for disposal concepts, to support for a licence application for disposal or for upgrading the safety of an existing facility requiring detailed, site-specific safety indicators assessment against regulatory criteria. In addition there can be a variety of additional purposes, such as derivation of quantitative acceptance criteria.

The audience to whom the results of the safety assessment will be presented should be identified. The general purpose and the target audience (e.g. regulators, operators; waste producers; local, regional and national politicians) may play a key

role in defining relevant assessment end-points, key assumptions concerning the disposal system and in the identification and justification of the assessment scenarios.

(b) Regulatory Framework

In undertaking an assessment it is necessary to consider the regulatory framework that is relevant to the safety assessment. At one extreme this might be a detailed, prescriptive framework, at the other it might be non-prescriptive or may not have been fully developed. While national regulatory frameworks vary considerably, they mostly have some link to international recommendations relating to the management of radioactive waste disposal such as the IAEA Principles of Radioactive Waste Management [1], and ICRP Publications 77 and 81.

(c) Assessment End-Points

The end-points of an assessment need to be well defined, correspond with the safety assessment purpose and the associated regulatory framework and take into account the assessment assumptions made concerning time scales and critical groups.

An additional consideration is that the trend in safety case development is not to rely on evaluation of just a single end-point, such as individual dose (the most commonly used end-point is a survey of ISAM participants). Multiple lines of reasoning may be useful since regulatory bodies and others may use a wide range of arguments and end-points to help determine the adequacy of a safety case. A variety of indicators may be used as alternatives and in addition to dose and risk (such as radionuclide fluxes and concentrations).

(d) Assessment Philosophy

The assessment philosophy is an expression of the extent to which the assessment is designed to provide a "realistic" estimate of potential impacts for comparison with the assessment end-points, or whether more cautious, or pessimistic assumptions should be adopted for the purposes of demonstrating compliance with safety requirements.

(e) Timeframes

The waste disposal option adopted should ensure equitable protection of both current and future generations and this will involve balancing greater certainty for shorter time periods with increasing uncertainty over longer time periods. The timeframe for the post-closure safety assessment should be selected, recognising inherent limitations and uncertainties in assessment approaches, as well as constraints on the scientific credibility of long-term estimates of disposal facility performance imposed by large-scale environmental changes. The timescale of interest for an assessment can be a function of the nature of the waste disposal system and the external influences on it, and the longevity of the radionuclides in the waste. Therefore the timescales of an assessment should be justified on a case-by-case basis, although some may also be imposed by regulatory requirements.

(f) Disposal System Characteristics

The disposal system can be considered to consist of: the near field; the geosphere; and the biosphere (Section A.2). These components are described in more detail in the next step of the assessment approach, the system description. However, it

is useful to provide, within the assessment context step, a brief overview of the present-day system and to document any associated high-level assumptions.

As part of the initial description of the system characteristics, assumptions concerning future human actions can be defined, such as, level of technological development, type of society, and basis for habits and characteristics. Similarly, assumptions concerning the characteristics of any groups of people, who might potentially be exposed to radionuclides released from the disposal facility, can also be defined. Alternatively they can be defined during the scenario development and justification process (Section A.3). What is important is that they are clearly identified and as far as possible justified at either of these two stages of the assessment process.

A2. Description of Radioactive Waste Disposal System

The disposal system description should contain information on:

(a) *the near field* – e.g. waste types, waste forms, waste inventory, disposal practices, engineered barriers (chemical and physical characteristics), facility dimensions;

(b) *the geosphere* – e.g. lithology, flow and transport characteristics; and

(c) *the biosphere* – e.g. exposure pathways, climate characteristics, human habits and behaviour.

This aspect of the safety assessment is important as it provides the information on the characteristics of the disposal system to be considered in the safety assessment. Therefore it is necessary to ensure that the data collected are pertinent to the assessment context. The limited availability or adequacy of data is an important factor in many safety assessments and hence when the developing the system description, it is important to be aware of and to document the assumptions made and the associated uncertainties.

A3. Development and Justification of Scenarios

The safety assessment for a waste disposal facility must address the performance of the disposal system under both present and future conditions, including anticipated and less probable events. This means that many different factors (e.g. conceptual model and parameter uncertainty, long time periods, human behaviour and climate change) must be taken into account and evaluated in a consistent way, often in the absence of quantitative data. A very broad range of combinations can result from these considerations, which need to be addressed in a manageable way. This is often achieved through the formulation and analysis of a set of scenarios describing alternative future evolution and conditions. The selected scenarios need to provide a comprehensive picture of the system and its possible evolution based on the assessment context and system description. The choice of appropriate scenarios and associated conceptual models is very important and strongly influences the subsequent safety assessment of the waste disposal system.

There are several methods that can be used to generate scenarios. These may involve expert judgement, fault tree and event tree analysis. A common element in many scenario generation methodologies is the systematic identification and consideration of Features, Events and Processes (FEPs) that can directly or indirectly

affect the release and transport of radionuclides from a disposal facility. Whatever approach is selected it is necessary to ensure that the scenario generation process is systematic, comprehensive, logical and transparent. By doing so a defensible representation of the system and its likely evolution over time can be developed.

A4. Formulation and Implementation of Models

Once the scenarios have been developed, their consequences in terms of the assessment context must be determined. First a conceptual level model representing each scenario must be established. Various assumptions will be necessary for this process addressing issues such as, boundary conditions, FEPs, FEP relationships, etc. For some scenarios it may be necessary to use a qualitative assessment approach (e.g. when data are not available). For the scenarios that are to be quantitatively assessed, the scenarios must be organised into a form that is amenable to mathematical representation. The conceptual models for each scenario should then be expressed in mathematical form, with appropriate and adequate initial boundary conditions. Solution of the mathematical models is usually achieved by implementing one or more computer tools using analytic and/or numerical techniques and appropriate input data. It is necessary to ensure that the selected models and associated data correspond to the assessment context and represent adequately the disposal system.

A5. Analyses of Results and Confidence Building

Once the scenarios, and associated conceptual and mathematical models have been developed and implemented in software tools and the associated data collated, calculations can be undertaken to assess the impacts of a disposal facility. The results then need to be collated, analysed and presented. The results will have to be compared with criteria defined in terms of the specific assessment context. These will in most cases include regulatory criteria, although design and economic constraints may also be a major consideration. When analysing the results from an assessment, consideration should be given to various sources of uncertainty (e.g. scenario, model, data uncertainty).

The final results of the assessment often have to be presented to different audiences and for different purposes. Therefore it is also important that due care is given to the selection of approaches and means for presentation of results appropriate for the audience under consideration.

It is very important that the various parties who make use of the results have a reasonable degree of confidence in them and the underlying assessment. Confidence in the results is strongly related to the confidence in the consistency, logic and transparency of the overall safety assessment methodology used. Decisions often have to be made based on interpretation and analysis of the results as to whether the safety case is adequate.

It is important to underline that the entire safety assessment process is iterative and the first pass through the process should usually be followed by one or more iterations. This promotes consideration of improvements to the disposal system regardless of how favourable results initially appear. Subsequent iterations will often contribute to decisions whether the safety case is acceptable or there is a need for further improvements. Early iterations are undertaken with available data and assessment capabilities, and the iterations need only proceed until the assessment is

judged to be adequate for its purpose. Furthermore, new data need only be collected to the extent that they are required in order to provide an adequate basis for the decision.