

Environmental Impact Assessments and Geological Repositories for Radioactive Waste

P. O'Sullivan, B. McKirdy, M. Askarieh
United Kingdom Nirex Limited

A. Bond, S. Russell*
The University of Wales, Aberystwyth
(* now at Imperial College, University of London)

S. Webster
European Commission, Environment Directorate-General

Abstract

The Environmental Impact Assessment (EIA) Directive on the effects of projects on the environment was introduced as part of EU legislation in 1985 (85/337/EEC) and amended in 1997 (97/11/EC). The EIA procedure ensures that environmental consequences of projects are identified and assessed before development consent is given. The public can give its opinion and all results are taken into account in the authorisation procedure of the project. The EIA Directive outlines which projects shall be subjected to an EIA, the procedures to be followed and the content of the assessment.

Member States are given wide discretion on how the above requirements are implemented in practice, e.g. the Directives call for EIA results to be made available to the public before development consent is granted, but the detailed arrangements for such information and consultation is determined by individual Member States. Also, the Directives require an assessment of the *direct and indirect* effects of a project on human beings and on various elements of the natural environment, though they are non-specific as to what particular *impacts* should be addressed, particularly as regards the effects of a project on human beings. Therefore, for example, each Member State may decide whether or not social, health and economic impacts should be included in the assessment.

One project category listed in the EIA Directive concerns facilities designed for the permanent storage or disposal of radioactive waste. In addition, the amended EIA Directive adds "installations designed solely for the storage (planned for more than 10 years) of irradiated nuclear fuels or radioactive waste in a different site than the production site".

A recently completed 15-month study, carried out for DGXI (now the Environment Directorate-General) of the European Commission, investigated the scope and application of EIA legislation and current EIA practice in Member States and applicant countries of Central and Eastern Europe, specifically in relation to the geological disposal of radioactive waste. The level of compliance with the EIA Directives was determined, along with the extent to which international "best practice" has been adopted. The study went on to investigate a model approach to EIA in the context of geological repositories, including the role of the assessment on the overall decision processes for repository development, the scope and content of the assessment report, and approaches to public involvement. The study report is published in the Commission's "Nuclear safety and the environment" series, ref. EUR19152. The report also includes a summary of a workshop on the study's findings held in Brussels on April 20-21, 1999. The present paper summarises and discusses the findings of the above study.

1 Introduction

Under Council Directive 85/337/EEC, Environmental Impact Assessment (EIA) is a mandatory requirement, in all European Union (EU) Member States, in the case of a wide range of projects having potential impact on the environment. This includes installations “solely designed for the permanent storage or the final disposal of radioactive waste”. Under the amending Directive 97/11/EC this requirement is extended to “installations designed ... solely for the storage (planned for more than 10 years) of ... radioactive waste in a different site than the production site.”

In the context of the development of a radioactive waste disposal or long-lived storage facility, a study, funded by DGXI of the European Commission, examined the following aspects:

- National requirements for EIAs (EU Member States, EU applicant countries, Canada, Switzerland, USA), implementation of Directive 85/337/EEC and its amendment in the EU Member States and progress towards adoption of equivalent legislation in the EU applicant countries of the Central and Eastern European region;
- scope and contents of EIA reports;
- an idealised EIA process;
- the involvement of the public in the EIA process; and
- how the EIA would be affected by introducing measures to increase waste retrievability.

Directive 85/337/EEC establishes basic principles and procedural requirements for environmental impact assessment, allowing Member States considerable discretion in the details of implementation into domestic legislation, particularly as regards the specific impacts to be addressed and the nature of public involvement in the assessment process. The study examined how Member States had implemented Directive 85/337/EEC, as far as it concerned geological facilities for disposal and long-term storage of radioactive waste, and considered the scope for further harmonisation of procedural arrangements. The analysis included consideration of the contents of EIA reports and the role of the assessment in the development process for such facilities.

Information was obtained from a variety of governmental, national and other sources in the countries concerned principally by questionnaire.

The reader is referred to the study report [1] for the full details and results of this project.

2 Procedural Requirements for EIA

EU Member states

As would be expected, the study confirms that all Member States had legislation in force that implemented the requirements of the Directive. It is evident also that, at the time of the survey (April-September 1998) good progress was being made in implementing the amending Directive (97/11/EC) for which the deadline for transposition into National law was 14th March 1999. Indeed, many States indicated that their existing arrangements for EIA broadly met the requirements of the 1997 Directive. A schematic of the application of the Directive is shown in Fig. 2.1.

The following are identified as the main areas where Member States have most discretion as regards implementation of the provisions of the Directive:

- The precise role of the EIA in the decision process is not defined.
- The particular environmental impacts that should be addressed are not specified. The only requirement is an assessment of the direct and indirect effects of a project on human beings and the natural environment.

- The Directive does not specify requirements for public involvement in the EIA process, except to require that certain information are made available to the public in order that they can express an opinion before development consent is granted.
- Under the Directive, an EIA must include consideration of mitigating measures, though there are no requirements as to the arrangements for enforcing these measures.
- The Directive does not specify the role of the competent authority in the context of reviewing the adequacy of the EIA report.

Prior to the adoption of the amending Directive in 1997, the Directive only required a developer to provide information about alternatives considered “where appropriate”. This caveat was removed by 97/11/EC, thus ensuring that the EIA has an integral role in the process of selecting a preferred site for development.

As regards the potential for further harmonisation in those areas discussed above, the study report [1] argues that this issue needs to be considered in the context of the different legal and cultural frameworks in Member States (and in Central and East European countries). Whilst the overall goal should be to encourage all States to adopt best practices this is not likely to be hindered by the discretion allowed by the amended Directive, for example, the development of arrangements to enhance public involvement should take account of the cultural norms in the country involved.

It is nevertheless important that mechanisms are established to enable Member States and Central and East European countries to be aware, on an ongoing basis, of best practice in undertaking environmental assessments for waste management facilities. The publication of guidance on best practice considerations, by Member States and/or the Commission is likely to be helpful in this respect.

EU applicant countries

Prospective members of the European Union in East and Central Europe were surveyed, also by questionnaire, to determine the extent to which legal requirements and approaches to implementation were compatible with those in Member States.

In large part the countries surveyed have implemented legislation on environmental assessment, in some cases imposing requirements that go beyond those that would be imposed by the Directive. The survey found that legal requirements in most prospective members were broadly compatible with the Directive. The most significant area of inconsistency, between different countries and with the requirements of the Directive, was the lack of specific requirements in many countries in relation to the consideration of alternatives in the assessment process.

It is evident that there are some discrepancies between the legal requirements and their implementation in practice, largely in the context of public participation. To an extent this reflects the fact that the legal requirements are relatively recent and experience in undertaking assessments is not widespread. In particular, there was less emphasis on the need to develop interactive methods for participation than had been seen in the survey of Member States. This may indicate a lack of awareness of the benefits of using such methods or a conviction that the context is not yet appropriate.

3 Scope and Content of EIA Reports of Geological Repository Projects

The application of the Directive requirements will depend in practice on the nature of the environmental hazards posed by the project. In the particular case of a geological facility for radioactive waste the hazards can be categorised as short-term (i.e. hazards that exist whilst the facility is being operated) and long-term (i.e. hazards that exist after the facility has finished operation and has been closed). Also, in comparison with many other projects for which an environmental assessment is required, facilities for long-term management of radioactive waste have specific characteristics due to the main inherent hazard being the presence of radioactivity.

The environmental assessment must therefore address radiological impacts on people and on the natural environment, together with environmental impacts from other aspects of any proposed facility. The Directive does not mention social and economic impacts specifically though most Member States include these in the assessment, in line with best practice internationally.

The assessment of radiological impact has a number of different dimensions including:

- the impact on the workforce and the public during the period of operation of the facility, including hazards arising during waste transport;
- the long-term potential impact on future generations for both the normal evolution of the repository system and for less likely variant scenarios (see below); and
- the potential impact of radioactivity on the natural environment.

As well as the specific considerations arising from the radiological hazard presented by the waste a disposal facility will present a range of non-radiological hazards typical of a large engineering project involving the transportation of large containers to a central location and their emplacement deep underground. The assessment of risk from activities taking place during construction, operation and transport to the facility requires a systematic analysis of hazards and consideration of the probability of those hazards being realised, taking account of the protective measures envisaged to be in place. The assessment of the long-term potential impact from chemical hazards is undertaken using approaches that are similar in principle to those used to assess long-term radiological impact.

Indicators of Safety Performance

The acceptability of a proposed geological repository for radioactive waste will be determined to a considerable degree from an assessment of its potential impact on human health and on the environment. Such an assessment necessarily involves consideration of the pathways and transport processes for migration of radionuclides and other toxic materials through the engineered and natural barriers to the biosphere and the human environment. Measures of acceptability for operating nuclear plant are commonly based on limitation of radiological dose and/or risk to human beings but this approach on its own may not be appropriate for a geological repository.

There are uncertainties associated with calculations of dose and risk over extended timescales, not least because they rely on assumptions about the evolution of the natural environment and future human behaviour. Accordingly it may be appropriate to consider other safety indicators which provide additional information about whether the radiological and other consequences of a repository will be acceptable.

Mitigation Measures

In accordance with the Directive the assessment of environmental impact from a geological facility must include consideration of mitigation measures. A standard approach to addressing this requirement is to develop an environmental action plan. This would document the key environmental impacts identified by the assessment, the proposed actions to address the identified impacts, the implementation schedule and an estimate of the associated costs. The plan would document regulatory requirements including those relating to compliance and identify any specific regulatory consents needed. It would distinguish between issues to be addressed on a short timescale and those requiring a long-term approach. It is suggested that the EIA Report for a geological facility should contain details of the environmental action plan, in sufficient detail for the competent authority to be able to form a view on the adequacy of the measures being proposed. The study report suggests that a more detailed plan should be prepared before the construction of the facility begins.

4 Model Process for EIA of Geological Repositories

The process of developing a repository will necessarily include a number of discrete steps, with formal consents normally being required from national authorities before moving from one major phase to the next. In this context the major phases are site selection, construction of the facility, commencement of waste emplacement, closure of the facility and termination of institutional control of the site. An assessment of the likely performance of the facility, at an appropriate level of detail considering the stage of development, will be an important input to the decision process at each of the main consent points.

Development consent, as discussed in the Directive, implies the granting of permission to proceed with that part of the project involving “interventions in the natural surroundings and landscape” including “the execution of construction works or of other installations or schemes” (Article 1). The Directive requirements therefore relate largely to the site selection phase, though it is implicit that national authorities should take measures to ensure that the measures proposed to address environmental impacts are implemented in practice.

Under Article 8 of the Directive the body responsible for deciding whether development consent is granted for a project coming within the scope of the Directive (the competent authority) must take account of:

- the information supplied in the EIA Report; and
- the results of the necessary consultations with the public and other relevant authorities (including in other Member States where appropriate).

Although the environmental assessment process is linked to the consent process there are no strict requirements as to the extent to which these two activities are integrated. The EIA Report could be regarded as one of many submissions from the proponent to the competent authority, or it could be used to draw together all the main arguments being advanced by the proponent for seeking to proceed with a particular project. The present study favours the latter approach.

It is important to note that the assessment should include:

“... an outline of the main alternatives studied by the developer and an indication of the main reasons for his choice, taking account of the environmental effects”. (Article 5(3))

The practical effect of this requirement is to make it obligatory (for installations for which an environmental assessment is required) for a developer to study alternative options to that being proposed in any application for development consent, unless there clearly are no real alternatives. Therefore, although there is no explicit requirement for the EIA process to be integrated closely into the process of site selection and project development the requirements of Article 5(3) make this unavoidable. The EIA Report should incorporate information on the assessed performance of the preferred site for development together with comparative information for alternative sites.

In principle the requirement on a developer to give details about the main alternatives studied applies both to the waste management process being advanced as well to the choice of a particular site for development of a disposal facility. Consideration of alternative waste management options could take place in connection with an application for development consent at a specific site, or this could largely be addressed in advance of site selection through a strategic environmental assessment of waste management options.

Although such a process of early strategic evaluations is outside the scope of the Directive (being the subject of a draft Directive concerned with strategic environmental assessment of ‘plans and programmes’), it does provide a convenient mechanism for discussion of issues of principle in advance of considerations about a specific project. The study noted that in some countries (notably

France) development work relating to a range of waste management options is being taken forward in parallel, with a decision on which option to pursue to completion being taken at a relatively late stage.

In principle, the process of selecting a site for a facility for disposal of radioactive waste could follow an approach based on screening of potential sites on the basis of pre-established technical and other criteria, or an approach based on volunteerism by local communities, or on some combination of these two approaches. Regardless of the precise method for site selection adopted, the siting process will generally be organised in the following four stages, as set out by the International Atomic Energy Agency (IAEA):

- concept and planning;
- national and area survey;
- site characterisation; and
- site confirmation.

The model process proposed in the study report is based around these stages, and is shown schematically in Fig 4.1.

The major decision milestone is the point at which consent is sought from the competent authority to proceed with development of the facility. It is suggested that the application for development consent should be made following the selection of a preferred site, i.e. at the end of the site characterisation phase. It would be expected that consent granted then by the competent authority would be made subject to the satisfactory completion of underground testing during the site confirmation phase. Nuclear safety legislation in most Member States would require a further formal consent, for example, by regulatory authorities, before starting construction of the major components of the facility.

5 Public Participation

The nature of public involvement in decision-making relating to the development of a geological repository will differ according to the different stages of the project itself. It is suggested that, in the early phases of a project (before potential repository sites are identified), decisions are required at national level relating to strategic issues such as the overall waste management strategy. During the siting process the focus of involvement will move towards those regions that appear to meet the basic siting criteria, and finally to local communities as specific potential sites are identified.

Although the type of public involvement changes as the project progresses, it is possible to identify overarching principles that apply at all stages of the process. A basic objective for any public participation activity is to achieve a certain level of public awareness: the level of existing awareness must therefore be determined at the outset by market research techniques. Ultimately the objective should be to develop a waste management strategy that is both technically sound and has broad public understanding and support.

Any attempt to involve the public in an effective way should adhere to the following principles. Participation should be:

- started early and occur throughout the process (with defined cycles of activity);
- interactive – a two-way process including feedback; and
- inclusive, transparent and honest.

A key requirement will be the development at the outset of a public involvement programme that defines the overall objectives and outlines a series of public activities connected with the various

phases of the assessment process. The programme will need to provide for easy access by any interested individuals and must be seen as being fair, i.e. the public must be able to contribute to defining the scope and nature of the programme itself.

An important requirement at the outset of any public involvement programme will be to develop an understanding of the key social characteristics of the community concerned (which may be at national, regional or local level). The process of public participation may be enhanced by:

- Open Houses;
- Planning Workshops;
- Community Advisory Committees;
- Citizens' Juries and Consensus Conferences;
- Participative Social Impact Assessment and Management.

The reader is referred to the study report [1] for a full description of these processes. It is important that mechanisms are put in place which ensure that queries raised by members of the public are considered by proponents, with visibility of how the query is addressed, for example, by providing access to correspondence dealing with that issue. The degree of ongoing involvement by the public will depend on the extent to which it believes that it is able to influence the decision-making process.

6 Effect of Retrievability on EIA for Waste Management Facilities

In comparing the environmental impact of different options, it should be noted that the extent to which various activities would give rise to environmental effects is highly dependent on the specific site to be considered. This study considered three different options in general terms: long-term surface or near-surface storage, and deep underground disposal with and without provisions for easy retrieval of the waste.

In principle, assuming a safety case meeting national and international regulatory criteria had been made, the emplacement of waste in a deep geological facility without an intention to recover the waste would minimise the ongoing exposure of the workforce to radiation resulting from a continued requirement for surveillance and monitoring. Similarly, this option should in principle provide most protection to the public assuming both normal evolution of the repository system and the occurrence of abnormal events.

As regards an option involving long-term surface or near surface storage, the storage facilities are likely to be significantly more vulnerable to damage, particularly in the event that future society is less stable or does not possess the required levels of technological capability.

The level of protection provided by a facility incorporating features to enhance waste retrieval in an underground facility would be marginally less than one that was sealed and closed after completion of waste emplacement. Continued access to the waste would inevitably mean that some of the barriers providing long-term protection would be put in place significantly later than when the waste itself is emplaced. In these circumstances long-term performance of the disposal system would be reliant on future generations having the will and the technological capability to put adequate barriers in place.

The environmental assessment process for a facility that included features to enhance the retrievability of waste would follow the same overall approach as for a facility without such features. The incorporation of these features may have implications for the nature and magnitude of the environmental impacts, particularly if the operational lifetime of the facility is extended substantially. Such implications may include:

- immediate safety implications for the workforce;
- potential long-term implications for the safety of the general public;
- radiological and non-radiological impacts on the natural environment; and
- social and economic impacts.

The EIA Report should discuss these environmental impacts and propose measures for dealing with them. Many Member States favour a step-wise approach to repository development, whereby the present generation establishes a facility for long-term management of the waste, whilst allowing future generations the option of adopting different management strategies if they wish. These aspects should also be addressed in the EIA Report.

7 Summary

An EIA is a necessary and important part of the development of a case for a geological repository for the long-term or final storage of radioactive waste.

Although there is a mandatory requirement in the EU for an EIA in the case of such projects, Member States are allowed considerable discretion in the details of transposition into domestic legislation. As a result, requirements may vary from state to state leading to differences in the role played by the EIA and the detailed requirements. The paper presents a suggested 'model' approach to EIA of facilities for long-term storage or disposal of radioactive waste. The objective is to illustrate best practice and to facilitate consideration of the potential for, and/or benefits of, greater harmonisation of approaches across Member States.

There is growing recognition that lack of consultation and public involvement can mean that those affected by a proposal are either unaware of the proposal or feel their needs or concerns are not taken into account. In turn this makes it more likely that implementation will be impeded by opposition and protest. However, it is widely recognised that EIA can be used as a vehicle for effective communication with the public. The role and value of public participation are considered in the paper and recommendations are made on methods and techniques for effective incorporation of public participation into the EIA process.

The scope and information content of an EIA report for radioactive waste facilities are discussed. Particular consideration is given to the implications for the environmental assessment of using a number of different points of reference, 'safety indicators', against which to evaluate the effects of such facilities on human health and the environment.

Finally, since there is a growing discussion as to the benefits of 'retrievability' of waste from a disposal facility, the implications for EIA of a requirement to incorporate design features to enhance retrievability are discussed. Three waste management options are considered in the context of retrievability of waste, and the potential impact on the environment and any associated modifications to the EIA requirements in the context of each of the three waste management options is discussed.

8 References

- [1] Environmental Impact Assessments and Geological Repositories for Radioactive Waste; Environment Directorate General, European Commission; Report EUR19152; October 1999 (also refer to <http://www.europa.eu.int/comm/dg11/pubs/nuclear.htm>)
The authors of this European Commission study contract final report are:
P. O'Sullivan, B. McKirdy, M. Askarieh (UK Nirex Ltd) A. Bond, S. Russell, S. Dagg, I. Russell (The University of Wales, Aberystwyth, UK) J. Alonso, J.L. Santiago (ENRESA, Spain)

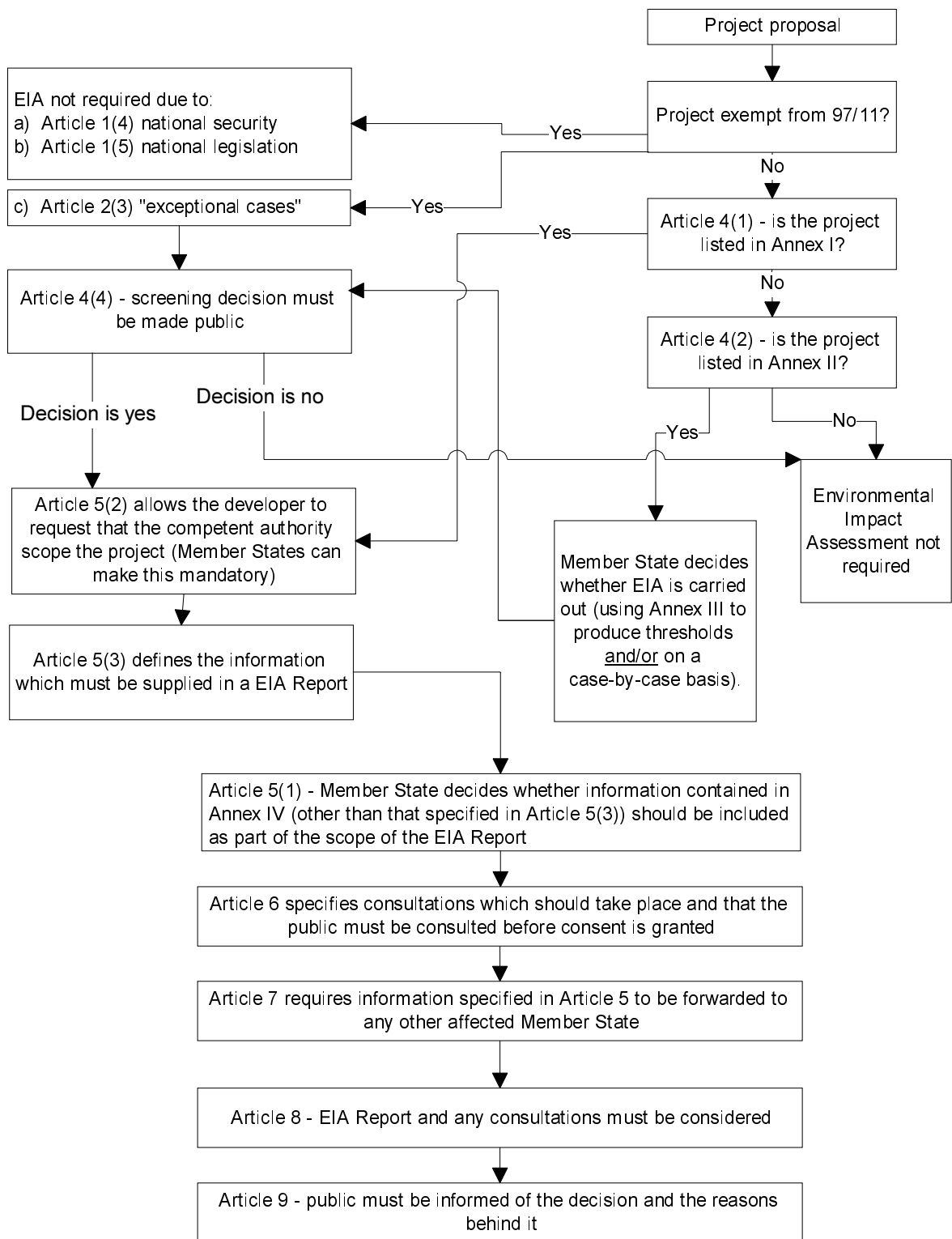


Figure 2.1. Requirements for Environmental Impact Assessment under Directive EC/97/11

Stages	Pre-EIA process	Concept and Planning	National and Area Survey	Site Characterisation	Site Confirmation
Main Activities	Establish Government Policy	<ul style="list-style-type: none"> • Generic disposal/storage concept • Plan for siting process 	<ul style="list-style-type: none"> • Identification of : <ol style="list-style-type: none"> a. areas for potential sites; b. potential sites 	<ul style="list-style-type: none"> • Surface-based investigations at potential sites • Determination of application by competent authority 	<ul style="list-style-type: none"> • Underground investigations
EIA Process		<p>Development and strategic appraisal of:</p> <ul style="list-style-type: none"> • Generic disposal/storage concept • Plan for siting process • Screening guidelines and site evaluation strategy 	<ul style="list-style-type: none"> • Assessment of potential locations against technical and social siting criteria • EIA process in relation to drilling of boreholes at the identified potential sites (where applicable) 	<ul style="list-style-type: none"> • Site specific and design specific environmental and social assessments • Evaluation of alternatives and selection of preferred site for development 	<ul style="list-style-type: none"> • Preparation of detailed performance assessment • Monitoring of compliance with conditions of development consent
Public Participation	<ul style="list-style-type: none"> • Consultation by Government on radioactive waste management policy • Develop public education programme (where appropriate) 	<ul style="list-style-type: none"> • Undertake social profile and stakeholder analysis • Develop public involvement programme • Measure public support for specific proposals 	<ul style="list-style-type: none"> • Prepare area and community social profiles • Develop mechanisms for interaction with interested communities • Implement public involvement programme (at regional and local levels) 	<p>Ongoing implementation of public involvement programme, including:</p> <ul style="list-style-type: none"> • Consultation on programme for EIA process ('scoping') • Evaluation of environmental and social impacts • Consultation on EIA report 	<ul style="list-style-type: none"> • Continuing interaction with local community about development of final design and mitigation of environmental impacts • Feedback results of ongoing investigations to local community and to interested groups at regional and national level
Formal Decision Points		<p>Endorsement of plan for siting process by relevant authority</p>	<p>Development consent for boreholes by competent authority</p>	<p>Development consent for project by competent authority</p>	<p>Consent for construction by regulatory authorities</p>

Figure 4.1. The EIA Process for a geological repository or long-term storage facility