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Environmental impact assessment for uranium mine, mill and in situ leach projects

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FOREWORD

Environmental impact assessments and/or statements are an inherent part of any uranium mining project and are a prerequisite for the future opening of an exploitation and its final closure and decommissioning. Since they contain all information related to the physical, biological, chemical and economic condition of the areas where industrial projects are proposed or planned, they present invaluable guidance for the planning and implementation of environmental mitigation as well as environmental restoration after the mine is closed. They further yield relevant data on the socio-economic impacts of a project.

The present report provides guidance on the environmental impact assessment of uranium mining and milling projects, including *in situ* leach projects which will be useful for companies in the process of planning uranium developments as well as for the regional or national authorities who will assess such developments. Additional information and advice is given through environmental case histories from five different countries. Those case histories are not meant to be prescriptions for conducting assessments nor even firm recommendations, but should serve as examples for the type and extent of work involved in assessments. A model assessment and licensing process is recommended based on the experience of the five countries.

The authors are from four major western uranium production companies and one regulatory agency. They have experience in countries with mature uranium industries and a variety of comprehensive environmental assessment systems.

The TECDOC is one in a series of IAEA publications covering all aspects of the uranium mining industry, from exploration to exploitation and decommissioning. Reports already published address topics such as feasibility studies (Steps for Preparing Uranium Production Feasibility Studies: A Guidebook, IAEA-TECDOC-885, Vienna, 1996) and development of regulations (Guidebook on the Development of Regulations for Uranium Deposit Development and Production, IAEA-TECDOC-862, Vienna, 1996). Two further publications, one on good practice in the management of uranium mining and milling operations and the preparation of their closure, and the other one on the methodology for assessing the economics of various mining methods for different types of uranium deposits, are currently in preparation.

EDITORIAL NOTE

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1. INTRODUCTION

1.1. BACKGROUND

Throughout the 19th and much of the 20th centuries stacks belching thick smoke were considered signs of progress and prosperity. In the latter half of the 20th century, the public and governments have become increasingly sensitive to environmental impacts from industrial activities and most countries now have some sort of environmental assessment process.

Environmental assessment has been an important consideration for the nuclear industry since the creation of the International Atomic Energy Agency in 1957; however, the degree to which environmental assessment has been embraced varies from one country to another. The past 20 years have seen a rapid growth in environmental legislation with increasing requirements for environmental assessment. Thus, environmental assessment is still an evolving process. This document gives guidance for environmental assessment of uranium mining and milling projects, including *in situ* leach projects, as practiced in several countries with a long history of uranium production and highly developed environmental assessment systems.

The Brundtland Report [1] defined sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. Mining, by its nature, is exhausting a resource which has a finite limit, albeit a limit that is influenced by economics (i.e., as price rises, more low-grade mineralization becomes ore.) The important issue in mining for a sustainable future is not to exhaust all types of mineral resources but, rather, to utilize mineral resources selectively, leaving some options for the future.

Uranium is mined to provide fuel for nuclear powered electrical generating stations, and in so doing it preserves other fuels, such as liquid hydrocarbons, which have more valuable uses than electricity production (e.g., as transportation fuels). In addition, nuclear power generates electricity without releasing large quantities of "greenhouse gases" and, thus, may avert future severe environmental consequences. World coal resources exceed current uranium resources in terms of available energy, but better technology is required before these resources can be fully utilized without environmental risk. Nuclear power has demonstrated the ability to produce electricity with acceptably low environmental impacts and, thus, can fill current energy demands while improved technology is developed to utilize other energy sources in the future.

1.2. JUSTIFICATION AND DEFINITIONS

Mining should be conducted in such a manner that the environment is not damaged to the extent that large areas of land are permanently removed from future beneficial use. Hence, it is important that an assessment be done of the potential impacts of a mining operation and that the development proceed in such a manner as to keep environmental degradation as low as reasonably achievable.

The following definitions describe the terms as used in this document, but it is recognized that terminology differs from one country to another and that these terms may have special meanings in some jurisdictions, which go beyond what is intended here.

The *environment,* in the broadest sense, encompasses man and his world, comprising both animate and inanimate components. The physical environment includes surface geography, geology, soils, climate, surface water, and groundwater. The biological environment comprises all living organisms, including plants and animals (both vertebrates and invertebrates). In examining the environment through various trophic levels, impacts on human health are ultimately considered.

Increasingly in many countries, the social and economic (frequently called socio-economic) environment is included in environmental assessment. Social and cultural issues may be more important where mines are proposed in undeveloped areas which may be populated by indigenous people who have a very different culture from that of the society interested in developing the mine.

Environmental impact assessment (EIA) is a process in which environmental factors are integrated into project planning and decision making. An environmental impact assessment is comprised of an examination of the local environment around a proposed project, an examination of the proposed project, and a prediction of the potential impacts of the project on the physical, biological and socio-economic environment, with the objective to judge the acceptability of the project and control those impacts to acceptable levels, while maintaining the viability of the project.

An *environmental impact statement* is a document which describes the local environment, the proposed project, its potential impacts on the environment, and possible mitigating measures. This document is a tool used in the assessment of the impact of the proposed project.

1.3. PARTICIPANTS

Generally, the environmental impact statement is produced by the proponent of the mining project, often with the assistance of specialist consultants. Members of the public in the area of the proposed development may have legitimate concerns about the nature and impacts of the project; their concerns should be identified and addressed. The third participant in environmental assessment is the authority which will judge the acceptability of the project and, if deemed acceptable, will issue the appropriate approvals.

1.4. PURPOSE OF ENVIRONMENTAL ASSESSMENT

The purpose of environmental assessment is, by examining the environment and the project, to assess potential impacts of a project on the physical, biological and socio-economic environment with a view towards determining mitigating measures for significant impacts and ultimately judging the acceptability of the project, balancing the potential impacts against the benefits.

It should be recognized that all the impacts and benefits of a project may not necessarily accrue to the same area or population. A mine may have local impacts that a small group of people may deem to be unacceptable, but the uranium from that mine may fuel a nuclear power programme which provides a greater benefit to the entire population of the country. In such a circumstance, the decision may be to proceed with the mine and negotiate some reasonable compensation to the community or persons in the affected region.

1.5. SCOPE AND LIMITS

A country, in making an initial decision on a nuclear power programme, may wish to examine a broad range of ethical and moral issues, such as the potential for weapons proliferation and the problem of fuel waste management, but once these matters are considered and decided, there should be no need to re-examine these policy issues for every new development that is proposed.

Similarly, there has been a tendency to examine potential impacts by integrating tiny incremental exposures and doses over the entire population of the planet and over hundreds of thousands of years of future time. Such exercises have no meaningful bearing on a proposed uranium mining or milling project. It would be possible to justify infinite expenditure on protection or, conversely, to refuse any project for unacceptable impact if it were assessed on this basis.

What is needed is a realistic examination of the local impacts due to the project on the physical and biological environment, and of the broader implications where regional/national economics may be affected. Social and economic factors should be considered as part of the environmental baseline but, unless a extremely large project is proposed in an area which is very depressed economically, it is unlikely that a single mine would have a major impact. It would be unrealistic to expect a single project to substantially boost the economy of a whole region. If several projects were proposed in a region, it would be justifiable to consider cumulative impacts; however, this too is an issue that should be kept in perspective.

2. CONSIDERATIONS FOR ENVIRONMENTAL IMPACT ASSESSMENT

2.1. GENERAL

If all the interested parties (i.e., project proponent, regulatory authorities, and interested public) have the opportunity for input into developing the terms of reference for conducting the environmental assessment and the assessment is performed in conformity with the terms of reference, then there is a high probability that the environmental assessment process will be successful. In addition to identifying potential environmental impacts and specifying appropriate mitigative measures, the environmental impact statement must also incorporate plans for the final decommissioning and reclamation of the project. The regulatory authorities and the public must be assured that significant unavoidable impacts to the environment occurring during the production phase of a project will be reclaimed during the decommissioning phase.

Appendix I lists a number of factors to consider in drafting an EIS for an uranium project. The list should b viewed more as checklist than a firm recommendation to examine every topic in detail. For example, earthquakes and vulcanism are not an issue to be concerned about in northern Saskatchewan, but these are of vital interest on the Pacific coast of North America.

2.2. FEASIBILITY STUDY

After a potentially viable uranium deposit has been identified, it is normal to conduct a feasibility study to assess whether or not the deposit can be economically developed. The feasibility study usually entails the definition of the ore reserves and the design of a mining and milling method for recovering the uranium. The capital, operating and decommissioning costs are assessed and compared with the revenue which could be generated by the sale of the product. To properly conduct this assessment, it is important to do a preliminary environmental baseline study and to estimate the potential impacts of the project on the local environment. Coupled with this is the need to examine the regulatory requirements which may be imposed upon the development. Mitigation of undesirable environmental impacts and stringent regulatory requirements could significantly affect the economics of a project. It is important to assess these factors before proceeding too far with the development. The environmental information needed for the feasibility study is similar to that required for an environmental impact statement, but at a lower level of detail. From an environmental perspective, the feasibility study need only consider those issues which could have serious economic impact on the project.

2.3. BASELINE ENVIRONMENT

Through baseline studies the condition of the existing environment prior to development should be characterized and documented. The data collection should be focused on those environmental elements that have a likelihood of being affected by the proposed project. The baseline environmental conditions are important for two reasons: first, to assist the assessment process and second, to provide a record of initial conditions, which will be invaluable when project decommissioning takes place. Before proceeding with the detailed environmental studies needed to assess the impacts of the project, it is important to discuss the proposed project with the applicable regulatory agencies and with local residents. In some jurisdictions there is a specific requirement to determine the concerns of local residents and address these concerns in the environmental assessment.

The environmental baseline document should start with the project location described on a national, regional and local basis with increasingly more detailed maps. The regional and local geology and geography lead into a description of the local terrestrial habitat. Climate, surface water hydrology, hydrogeology, water and air quality, and natural radiological conditions should be described. Following the description of the physical environment, the biological environment should be described. This will include primary producers, herbivores, omnivores and carnivores. Any rare or endangered species in the area of the project should be identified. After describing the biophysical environment, resource use should be described. This should encompass land use, agriculture, livestock, wildlife harvesting, fishing, tourism, etc. Finally, the socio-economic environment should be described, indicating the inhabitants of the area and the nature of their livelihood and culture. The level of investigation of each of these issues is dependent on the size and type of project, e.g., air quality may be a major issue at an open pit mine but a minor one at an *in situ* leach (ISL) project.

Table I below shows the elements that are typically considered in designing a baseline data collection programme.

TABLE I. ELEMENTS TO DESIGN A BASELINE DATA COLLECTION

PHYSICAL	BIOLOGICAL	SOCIO-ECONOMIC
Topography	Fauna, terrestrial agnatic	Land use
Geology	Flora, terrestrial agnatic	Water use
Hydrology/hydrogeology	Endangered species	Industrial activity
Climate	Radiological analyses	Cultural resources
Soils		Local population
Air quality		Employment
Radiological background		

2.4. PROJECT DESCRIPTION

The project should be described in detail, including the mine, mill, waste management system, and transportation of both raw materials and product. The mine description should start with a description of regional and local geology, leading into the mineralization and ore reserves. The mine description will vary, depending on whether it is underground, open pit or ISL. An open pit mine could require extensive de-watering, will certainly have large waste rock piles, and may produce a significant quantity of mineralized waste. An extensive area of land surface may be occupied. An underground mine will disturb less land surface and will usually generate less waste rock, but will normally require mine de-watering and an extensive ventilation system, resulting in several additional atmospheric emission points.

For both underground and open pit mines, waste rock management is an important consideration. Leachate arising from precipitation percolating through the waste rock can be a significant source of ground and surface water pollution. Waste rock piles are also sources of airborne dust and, depending upon the degree of mineralization, can represent a radon source. Ore stockpiles can be more important sources of water pollution and have to be managed accordingly. Although airborne radioactivity from uranium mines usually does not represent any significant environmental hazard, there is often considerable public concern on this issue. Hence, it is important to address this aspect in some detail.

The mill process should be described, starting with the mineralogy of the ore. The steps in treating the ore should be described, including process flow diagrams and approximate equipment lay-outs. The various steps usually include crushing, grinding, leaching, solids-liquid separation (often by counter-current decantation), clarification, purification and concentration (by solvent extraction or ion exchange), yellow cake precipitation, drying and packing, raffinate and residue neutralization, and effluent treatment. Airborne emission controls, such as scrubbers and dust collectors, should be described and expected emissions should be quantified.

For an *in situ* leach project, there is much less surface disturbance, and no waste rock or tailings are generated. The planned drilling activities, pumping system and uranium processing system should be described. Hydrogeology is particularly important for this type of operation.

Although not strictly environmental matters, safety and radiation protection of workers are frequently issues in environmental assessments. Therefore, the mining method should be described, including types of equipment, types of work, safety analyses and radiation exposure estimates. The equipment lay-outs will be helpful in estimating exposure.

Waste management considerations are important for all types of uranium mining operations. As applicable, plans for disposing of tailings, waste rock, liquid wastes, garbage and contaminated wastes must be identified.

Resource requirements should be catalogued. These may include electricity, water, fuel, chemical reagents, and construction materials.

A conceptual decommissioning plan should be part of the of the project description, because the emissions after decommissioning are likely to be very different from those during operation, and may continue for a very long time.

In describing the project, it is often useful to mention the options considered for the development and the reasons for selecting the preferred option. It can also be beneficial to give some consideration of the impacts of not proceeding with the project.

The description of all of the above factors will allow potential emissions into the environment from the various facilities to be quantified. The design of mitigative measures will depend on a sound estimate of the amount and type of emissions.

2.5. IDENTIFICATION OF SIGNIFICANT ENVIRONMENTAL IMPACTS

Once the baseline information on the ecological, cultural, air, land and water resources has been collected, and the mining plan established, it is possible to identify the probable environmental impacts. Concurrently, impacts to the local social structure and economy are estimated. The level of effort and detail spent in collecting baseline information and identifying potential impacts should be related to the planned activities. Investigation of significant impacts must consider the short and long term, and each phase of the project (i.e., construction, mining, decommissioning and post decommissioning). Ecological risk assessment is a useful tool for evaluating the importance of various factors to the environmental assessment. This process identifies potential undesirable ecological impacts, estimates the probability of their occurrence and evaluates the ecological consequences of such impacts should they occur. Appendix II describes the methodology for performing ecological risk assessment.

The nature of the ore body and waste rock, and the planned mining method can have a major influence on the severity of the impacts to the environment. In some situations it may be necessary to modify the mining method to reduce the probable impacts to the environment to an acceptable level. Detailed planning during each phase of the mining project can help reduce impacts to the environment.

2.5.1. Construction Phase

To develop a mining project the proponent will need to construct various facilities related to the extraction and processing of the mineral. These facilities may include such items as access roads, power lines, processing plant or mill, office, camp, ore storage areas, tailings disposal area, etc. The proponent must identify potential environmental impacts from the planned construction activities in order to develop mitigative measures or modify the construction plans such that significant impacts are avoided.

2.5.2. Mining Phase

The mine plan and mining method selected for a project must take into consideration the potential impacts to the environment. The assessment of waste rock properties should be used to predict potential impacts of the waste rock on the local environment during the mining phase. Ore transport to the mill may have significant impacts. The quantity and quality of mine water can affect local surface waters and must be considered in the water treatment plant design. In some cases airborne particulate from waste rock and ore stockpiles may be important.

2.5.3. Decommissioning Phase

The planning for a project must include reclamation and decommissioning planning. Sometimes minor adjustments in the mine plan or changes in the mining method can result in considerable savings in decommissioning expenses. Potential impacts to the environment as a direct result of decommissioning activities must be assessed. For example, if rock of a certain specification is needed for stabilizing the surface of a reclaimed tailings pile, then the environmental impact of mining and crushing the rock must be assessed.

2.5.4. Post Decommissioning Phase

A major aspect of the environmental assessment process is the determination of the impacts to the environment following decommissioning and final reclamation. This assessment can not be made unless the pre-mining environment has been accurately documented in the baseline studies. The post decommissioning phase should include a reasonable period of time for the reclamation programmes to achieve the designed objectives. For example, in some areas it can take several years for a re-seeded area to reach the necessary level of vegetative productivity. A post decommissioning programme for monitoring and reporting the effectiveness of final reclamation activities will be a necessary part of the mine permit or licence.

2.6. MITIGATION AND PREVENTIVE MEASURES

From a knowledge of the mine plan and the pre-mining condition of the environment developed through the baseline studies, it is possible to determine the kind and amount of probable impacts to the environment. In some cases the impacts will be temporary and can be successfully dealt with during decommissioning. Some impacts may be so minor that they will be acceptable to the government and the public. There may, however, be situations where impacts are significant and must be either prevented or mitigated.

During construction, the amount of extraneous land disturbed for roads and material storage areas can be reduced through careful planning. Construction contractors must be briefed to minimize disturbance to land, vegetation and wildlife, and their performance in this area must be closely monitored. They must also be instructed to report encountering any cultural resource and, if encountered, to stop construction activities until the situation can be properly investigated. The contractor must dispose of any waste and trash that is generated during construction in an approved manner.

Preventive and mitigative measures may involve establishing controls (e.g., treating water before discharge) or modifying the mine plan (e.g., use of a grant current to protect an aquifer). Any change in the mine plan must be carefully evaluated in terms of project economics. The mining, milling and environmental departments at a mine should work together at the project planning stage to develop effective preventive and mitigative measures. For example, the selection of a tailings disposal area and disposal method can significantly affect the amount of land disturbed, the quantity of seepage and the ease of reclamation. An inexpensive change in the mine plan or the milling procedures can sometimes result in a significant decrease in the impact to the environment and/or reduce the cost of the decommissioning.

2.7. DECOMMISSIONING AND RECLAMATION

A major aspect of the environmental assessment process is the development of the decommissioning and final reclamation plan, including the reclamation of all land, air and water resources that are projected to be adversely affected by the mining and milling operation. The decommissioning plan should be based on a number of factors including the mine plan, and the baseline environmental information, and should consider those factors that will assure the long-term mechanical, geotechnical and geochemical stability of the site.

The mine plan and decommissioning plan should be integrated to the extent possible, such that reclamation of a disturbed area can be started as soon as mining is completed. An example of this is coal strip mining in North America, where waste rock and overburden from a new cut is placed in the cut that has just been mined. This eliminates multiple handling of waste rock and overburden and allows revegetation efforts to start immediately instead of waiting until all mining has been completed. Significant economic savings to the owners of these mines results from this practice through a decrease in reclamation costs.

The decommissioning plan should be based on the applicable government regulations and should include, but is not limited to, the following:

a) long-term stabilization of tailings system;

b) decontamination of radioactive equipment, buildings, etc., to the extent practicable;

c) recycle or disposal of hazardous materials such as explosives, fuels and chemical reagents;

d) removal and/or disposal of radioactively contaminated materials, buildings, etc., in an approved disposal site;

e) recycle of salvageable equipment and materials;

f) disposal of non-recyclable equipment, buildings, etc.;

g) removal of mineralized waste rock from the active surface environment;

h) disposal of water treatment plant sludges;

i) disposal of radioactive drill core;

j) removal of all wells, casings, piezometers, etc., not required for continuing monitoring;

k) disposal of domestic and industrial wastes;

l) sealing of all mine openings.

The environmental assessment process for a new mine must include a review and evaluation of the decommissioning and reclamation plan. This evaluation process needs to assess whether the proposed decommissioning plan will achieve the required results. If it appears that the decommissioning plan is inadequate in terms of complying with regulations or meeting performance standards, then the proponent of the project will need to re-examine the development strategy and possibly modify the mine plan or mining methods. A modification to the mine plan can impact capital and/or operating costs, requiring the proponent to reevaluate the project economics.

The environmental regulatory authorities in a country should have clear and straightforward decommissioning requirements that are uniformly applied to uranium mine and milling operations. This is important so that a company proposing to start a mine can perform a feasibility study which accurately estimates all costs of the project including decommissioning costs. The proponent also needs to be assured that decommissioning requirements will not significantly change after the mine or mill is in operation. Mining companies are unlikely to invest in countries where decommissioning and reclamation requirements frequently change and are retroactively applied to existing mining operations.

2.8. SOCIO-ECONOMIC IMPACT

An early relationship must be established with the various stakeholders, this will facilitate a consultative process and involve the community. This process brings out the community's needs, feelings and attitudes and the developer's needs, and is used to provide better social and economic benefits to the community and the developer.

The community must understand what the developer is doing, it must know what the cost and benefits are going to be to the community. The initial fears the community may have about the effects on its environment can be allayed by knowing what the effects are and how the developer will tackle them. The developer must show that the project is an ecologically sustainable one and he must show how the environmental, social and economic aspects are integrated into the project development.

In urban areas the community principle issues typically are:

- Personal safety in relation to the volume, rate and hours of traffic movements;
- Atmospheric emissions, dust, noise and vibration;
- After pollution;
- Hazards for children and the elderly;
- Ugliness, and the general appearance of the neighborhood;
- Concerns of people with alternative or opposing values;
- Concerns about what happens when the project ends — the subsequent use of the land and the impacts of closure on the community;
- Urban infrastructure; and
- Community facilities, education, health and leisure.

In agricultural areas or with indigenous communities the issues could include:

- Safety of people and livestock;
- Water pollution;
- Loss of or disruption to livelihood;
- Loss of or disturbance to heritage values;
- Loss or disturbance of natural values — biodiversity, conservation, vegetation, landscape;
- Limitations on access to areas of cultural or spiritual significance;
- Atmospheric emissions, including dust, noise and vibration;
- Increased traffic levels on rural roads;
- Loss of or disruption to traditional cultural values;
- Tourism; and
- Employment.

There is an expectation from the community that the developer will begin community consultation at the planning stage of the project and continue throughout the project life.

2.9. PARTICIPANTS IN THE PROCESS

2.9.1. Proponent

The proponent is that legal entity, which is proposing the establishment of a new mining and milling project or a significant change to an existing project (e.g. the development of a new ore body at an existing site). The proponent will usually make the applications for whatever approvals are required, perform the environmental field, work, produce the environmental impact statement, conduct a public information programme, defend the project in any hearings which may be required, respond to any requirements placed on the project by the process and initiate the actual project after the necessary approvals are received.

2.9.2. Regulatory Authorities

Most countries with uranium deposits have a competent authority which issues permits or licences for the operation of uranium mines and mills, inspects them during the operation and approves decommissioning. The licensing process may involve several stages, and an environmental assessment is a frequent requirement of the approval process. Depending upon the location of a proposed mining project, more than one level of government may have an interest in the development. For greater efficiency most countries combine these interests into a single process.

2.9.3. Public

For the purposes of environmental assessment, the public may comprise only the local inhabitants of the site of the proposed project, it may be the regional population, or the population of the country as a whole. Public input to an environmental assessment can occur at several points in the process. In some countries public meetings are held at the beginning of the process to solicit public views on the issues to be dealt with in the environmental impact statement. Whether this is required or not, the proponent is well-advised to seed the views of the public. After the EIS has been issued, the public generally is allowed to offer comments on it. In assessing the importance of the public input, proximity to the project site is an obvious factor. However, it is frequently necessary for an environmental assessment to balance impacts on a small local population against the greater good for the country.

3. CASE HISTORIES

3.1. AUSTRALIA

3.1.1. Process

An EIA process may be required by local, State or Commonwealth governments or may be a joint assessment process. (Steps are underway to improve the EIA process and reduce administrative duplication.)

In Australia an EIA may have several levels of assessment, some may involve public review. For projects that need major assessments, the developer produces an initial document called an Environmental Impact Statement (EIS). Smaller projects may require a lesser assessment called a Preliminary Environmental Report (PER). The level of EIA depends on the nature, complexity, its expected effects on the environment and the degree of controversy it has generated.

The assessing body (tier of government) will inform the developer of the assessment level required and provide guidelines for the EIS once it receives a Notice of Intention (NOI) from the developer.

The assessing authority may require public review or community consultation for major projects. If the initial information from the developer demonstrates it has satisfactorily considered the environment and has incorporated sufficient safeguards, then the assessing authority may not require a public review.

3.1.2 The Northern Territory Process

The flow chart, Fig. 1, describes the EIA process at the Northern Territory Government level (similar processes are undertaken by the various assessing authorities including the Commonwealth Government).

Various EIA documents will identify the issues that the developer has to consider. The assessing authority will draw up guidelines for the EIS and typically include the following topics.

3.1.2.1. General Description and Summary of Environmental Issues

- Name and address of developer
- Outline of proposal
- Regional geological setting
- Tenement status for project area
- Summary of key environmental issue

3.1.2.2. Description of Proposed Project

- Timeline for land clearing, construction commissioning
- Construction material, sources, transportation, storage and use
- Temporary construction requirements
- Mining development and operation
- Process and products
- Waste rock management
- Tailings disposal methods
- Water management

- Infrastructure
- Road access
- Workforce
- Benefits of the proposed project

3.1.2.3. Description of the Existing Environment

- Elements of the environment that may be affected
- Biophysical environment, climate land systems
- Hydrology
- Flora and fauna
- Noise levels
- Socio-economic environment
- Land tenure
- Paset — Aboriginal heritage — significance
- Aboriginal heritage significance
- Sacred sites

3.1.2.4. Potential and Actual Environmental Impacts, and Proposed Safeguards

- All impacts potential and actual have to be described
- Their magnitude and significance
- Appropriate safeguards should be developed
- Landforms and soil stability
- Water quality and surface or groundwater hydrology
- Impacts on flora and fauna from vegetation clearance and alteration to drainage
- Local community
- Transport corridors
- Air quality
- Noise levels
- Visual aesthetics

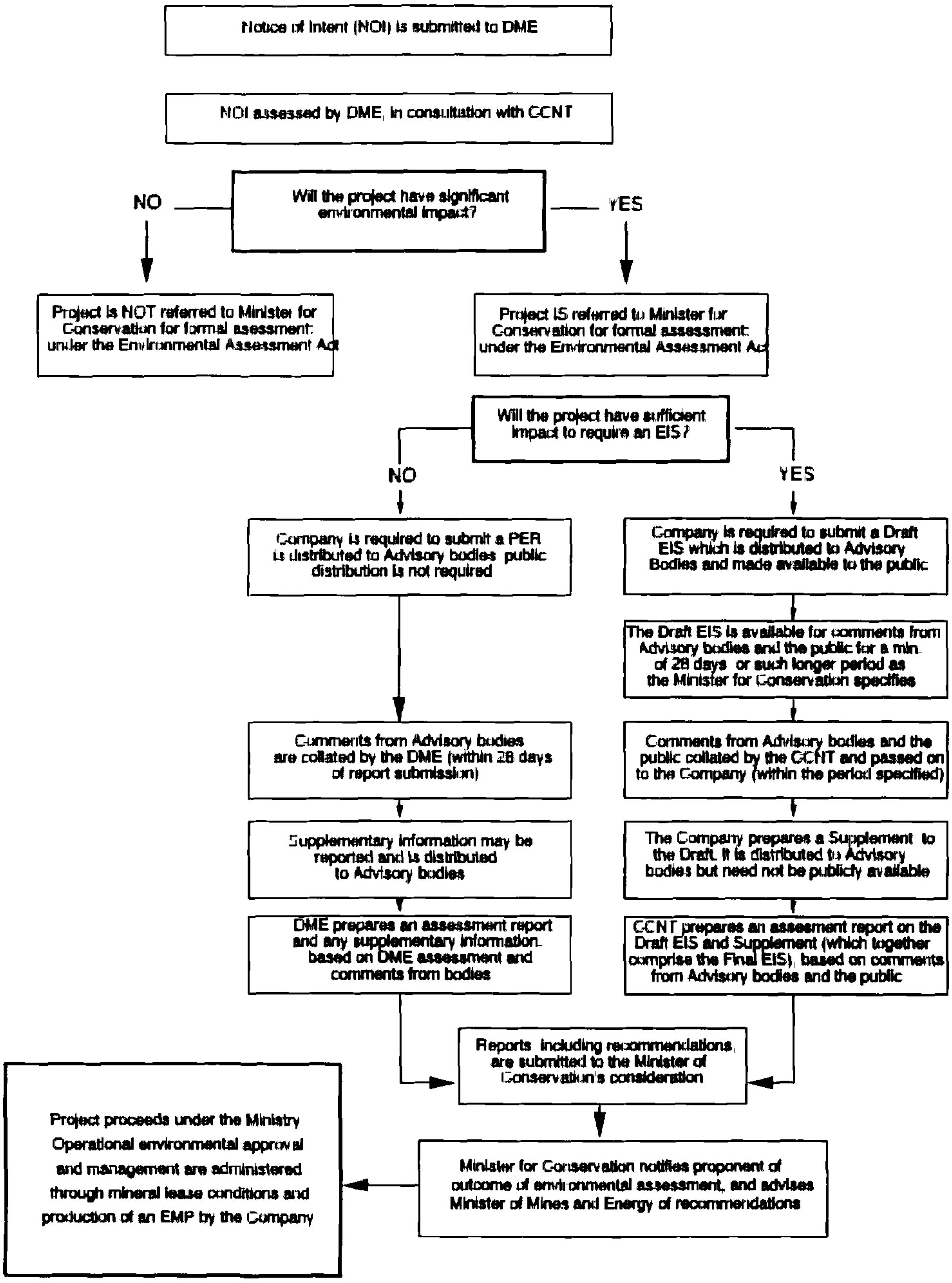
3.1.2.5. Environmental Monitoring

- Description of program
- Sample location, type and frequency
- Reporting frequency

3.1.2.6. Rehabilitation and Decommissioning

- Time scale for decommissioning
- Compliance with and release form government requirements
- Progressive rehabilitation
- Responsibilities of developer
- Continued monitoring

Environment Division
NT Department of Mines and Energy



DME = Department of Mines and Energy
CCNT = Conservation Commission of the Northern Territory
PER = Preliminary Environmental Report

Fig 1 Environmental assessment of mining project; Northern Territory - A brief guide

3.1.3. The Northern Territory Process (for a Gold Mine and Process Plant)

Below is a commentary of the EIA process for a gold mine in the Northern Territory. If this had been a uranium mine a similar process would apply. It is very likely that because of the emotional political aspects of uranium an EIA would be overseen by the Commonwealth and the Northern Territory agencies. This public/political input would result in a much longer approval process.

In September 1992 the Conservation Commission of the Northern Territory (CCNT) responded to the request of a developer on environmental requirements associated with their proposal to develop two open-cut mines. A draft inception report was completed and delivered to CCNT for comment in April 1993. The CCNT prepared draft guidelines for the preparation of the EIS and distributed these to various government instrumentalities for comment. The final guidelines document consisted of ten pages. The developer sent an Inception report on their development proposal to the Department of Mines in April 1993. This was the formal notification (Notice of Intention NOI) of the proposed project and the "trigger" of the assessment process.

TABLE II. TECHNICAL INFORMATION REQUIRED TO SUPPORT THE EIS

A	Meteorology of the Union Reefs Project Area
B	Hydrology and Water Quality
C	Authority Certificate issued by the Aboriginal Protection Authority for the areas to be
D	Surface Materials of the Union Reefs Project Area
E	Terrestrial Vegetation of the Union Reefs Project Area
F	Terrestrial Vertebrates of the Union Reefs Project Area
G	Fish and Selected Macroinvertebrates of the Union Reefs Project Area
H	Social Impact Study
I	Historical and Prehistoric Archaeological Heritage
J	Compilation of Issues, Safeguards and Residual Impacts
K	Technical Description and Specifications of Infra-red Bat Counters to Monitor Ghost Bat
L	Guidelines for the Preparation of an Environmental Impact Statement, Union Reefs Project
	Environmental Waste Rock, Marginal Ore and Process Residue Geochemistry
N	Management of Hazardous Substances and Dangerous Goods on the Union Reefs Project
O	Water Supply and Process Residue Storage Design Report
P	Regional Survey of the Union Reefs Project Area
Q	Land Systems of the Union Reefs Project Area
R	Assessment of Drilling and Blasting for Proposed Mining Operations (extract on 'Blasting')
S	Rehabilitation Plan for the Union Reefs Project Area

In May 1993 the Minister for CCNT was formally given notice of the proposal. Various meetings were held between the developer, instrumentalities and consultants prior to the developer submitting the preliminary draft EIS in August 1993. By September 1993 the developer had revised its timetable for the EIA five times. It is common for the proponent to underestimate the time to write, edit and re-edit reports. The various instrumentalities met with the developer on 7 September to discuss the project and the preliminary Draft EIS. On 10 September the developer lodged the Draft EIS with the NT Government for assessment and distributed the Draft EIS for public display. The contents of the draft EIS can be seen in Appendix III. Table II lists the technical information required to support the EIS. This technical information consists of numerous thick volumes, while the EIS is a relatively slim 100 page report. On 13 October the developer was sent a full set of comments. Approximately one month later the developer submitted his supplement to the draft EIS addressing all comments previously raised. Various instrumentalities and advisory bodies reviewed the supplement and within one month the developer sent the environmental assessment report (recommendation) to the CCNT Minister for endorsement. On the same day the CCNT Minister endorsed the recommendations and forwarded them to the Minister for the Department of Mines who notified the proponent of the completion of the assessment.

A typical checklist for an EIS can be seen in Table III. Changes to the Environmental Assessment Act will add another 28 days at the beginning of the process, this allows the guidelines to be scrutinised by the public (14 days public comment and 14 days to finalize the guidelines).

TABLE III. CHECKLIST FOR EIS ACTIONS

1	NOI application received.
2	Refer to DME/CCNT Standing Committee.
3	Mining Development deemed to require action under Environmental Assessment Act.
4	Project officer nominated from Assessment & Rehab branch.
5	PER requirement fulfilled, see PER checklist.
6	Minister for Conservation notifies proponent of the need for an EIS. Minister for Conservation notifies Minister for Mines and Energy
7	DME and CCNT meet. Guidelines agreed. Coordinating committee formed.
8	Advise proponent of guidelines and DME project officer. Coordinating committee meets with proponent if necessary.
9	Submit preliminary Draft EIS to DME. Circulate preliminary Draft EIS to coordinating committee for review.
10	Draft EIS submitted to Minister for Conservation and Minister for Mines and Energy.
11	Coordinating committee circulates Draft EIS to relevant advisory bodies. Minister for Conservation directs proponent to advertise the release of Draft EIS for public comment for not less than 28 days.
12	CCNT distributes public comments to DME, relevant advisory bodies and proponent.
13	Relevant advisory bodies meet to consider proponents response to comments.
14	DME advises proponent of any further requirements.
15	Coordinating committee provides advice on final submission to proponent if necessary.
16	Proponent submits Final EIS (due date determined by CCNT Minister)
17	CCNT circulates Final EIS to relevant advisory bodies for comment and coordinating committee meets. Coordinating committee makes recommendations to Minister for Conservation.
18	Minister for Conservation may request additional information (within 21 days of Final EIS). Minister for Conservation consults with Minister for Mines and Energy. Minister for Conservation makes recommendations to Minister for Mines and Energy (within 35 days of Final EIS or additional information or as determined).

3.2. CANADA

3.2.1. Federal Provincial Jurisdiction

In Canada, mining is usually considered a provincial matter, conducted under provincial laws, but atomic energy falls under federal jurisdiction. Hence, a federal government agency is the competent authority for uranium mining. The involvement of provincial government agencies is a matter of choice by the particular province. Should the province choose to be actively involved, there may be parallel licensing processes.

Canadian environmental assessment requirements are undergoing change with the introduction of a new federal environmental assessment act and regulations in early 1995. The new act requires that all new uranium mines, 35% or greater expansions of existing operations, and the decommissioning and abandonment of mining operations must undergo environmental assessment; however, no new projects have been proposed since the new act came into force. Consequently, no uranium project has yet been subjected to environmental assessment under the new act. Previously there was potential for duplication between provincial and federal environmental assessment requirements. The new act specifically demands co-operation between agencies which share environmental assessment responsibilities, so that duplication will be avoided. In the past, some uranium projects have been reviewed under provincial processes, some under federal processes and some under joint federal-provincial panels operating under the federal guidelines.

The two processes have differed in that the federal process, once initiated, required a hearing, whereas the provincial processes give the minister of environment discretion as to whether to call a hearing or not. The federal hearings were less formal, without legal counsel, sworn testimony or cross-examination, whereas the provincial hearings were quasi-judicial, with counsel, sworn testimony and cross-examination. The effect has been that federal hearings were shorter, less formal and encouraged more public participation, whereas provincial hearings were more formal, requiring a prospective participant to establish standing before being allowed to participate, resulting in less public participation and much more time to complete. The results of this have been that the provincial process has been more effective at constraining frivolous comment and eliciting the truth, but has been far more expensive.

3.2.2. Saskatchewan Process

A uranium mining company applied in July, 1991, for approval of the construction of a new tailings facility at a Saskatchewan uranium mining and milling operation. The provincial environment department deemed this to be a significant change under the terms of the provincial environmental assessment act and responded with a draft set of guidelines for the production of an environmental impact statement (EIS) in February, 1992. The revised draft was issued for 30 days of public comment in April, 1992. Final guidelines, taking into account comments received, were issued in August, 1992. The company proceeded to do the necessary studies, conduct several meetings between its consultants and interested regulatory agencies, and write the EIS, which was issued in February, 1994.

To avoid the necessity for a public hearing while addressing public concerns and to satisfy the federal licensing requirement for a public information programme, a series of public meetings was arranged in the northern communities nearest the mine site (still over 150 km away).

Both provincial and federal agencies reviewed the EIS and responded with technical comments in August, 1994. The company wrote an addendum to the EIS, which was issued in December, 1994. After further exchanges, a revised addendum was issued in March, 1995. The complete package of EIS, review comments and addendum was issued for a 30-day public review in April. After assessing the public comments, it was judged that a hearing was not required and provincial approval for construction was given in May, 1995. At the same time the federal agency screened the project for possible referral to the federal environment department, deemed this not to be necessary, and also issued construction approval.

Had a hearing been required, a provincial board of inquiry would have been appointed, several months would have elapsed while the board members familiarized themselves with the project, the hearings would then have been held, and the board would have reported back several months later, for a total additional time of at least nine months, delaying approval until 1996.

Appendix IV gives the table of contents for the EIS guidelines developed through the provincial process. Appendix V gives the table of contents of the resultant EIS.

3.2.3. Federal Process

Because the federal environmental assessment process has been evolving over a number of years, no uranium mining project can be regarded as a typical example. Under the pre-1995 federal process, a project requiring licensing by the Atomic Energy Control Board (AECB) could be referred to the Federal Environmental Assessment Review Office for a hearing, if the AECB screened the project and decided there were technical environmental issues that had not been properly resolved or that there was sufficient public concern.

In one case, a uranium mining company wanted to develop three new ore bodies at an existing mine site. The project was reviewed initially through the provincial process and approved for test mining. When the company applied for a production licence, the AECB screened the project and decided that there was sufficient public concern to refer it to a panel for a hearing. That decision was taken in February, 1991. A panel was constituted in November, 1991, and given terms of reference, which dictated subject areas to be assessed by the panel. Since an EIS already existed from the original approval process, no new guidelines were developed for an EIS. However, the company conducted a series of public meetings in the communities in the region of the project to determine the public concerns, and the EIS was revised to address these concerns and update the environmental data. The revised EIS was issued in June, 1992 (see Appendix VI for the Table of Contents of the EIS). The public review period lasted until late September, 1992. A request for additional information was issued in November, 1992. An addendum to the EIS was issued in March, 1993. A further request for additional information was issued in April with the additional information issued in May. The hearing proceeded in June and early July, 1993. The panel report was received in December, 1993, and the government response to the report was issued in February, 1994. The production licence was issued by the AECB in June, 1994.

3.3. FRANCE

3.3.1. Licensing Process in France

Exploration and mining of uranium deposits in France are controlled under the general legal framework of the extractive industry, with additional specific requirements because of the State interests in nuclear energy and radioactive materials.

The Mining Code is central to mining regulation; it refers to other acts and laws of general application in France. The most important of these relate to protection of nature, registered facilities for environmental protection, and public inquiries for environmental protection. These acts are complemented by other important regulations on water, air, wastes and noise, which introduce standards.

3.3.2. The Mining Code

3.3.2.1. Basic Considerations

The primary issue in this regulation is the definition of the relations between the owner of the land surface, the mine operator and the State, which is the owner of the mineral resources in the case of uranium. The objectives are:

- to promote the development of natural resources by improving the extraction conditions
- to enhance the state control over the natural resources management
- to reinforce the administrative supervision to achieve a better compatibility of the extractive industry with its environment.

The Mining Code considers two aspects:

- The particular rights which the operator can claim
- The practical conditions with respect to exploration or production activities

3.3.2.2. Mining Rights

Mining Exploration

The prospector requests an "Exclusive Exploration Permit" (EEP), granting to him the exclusive right to explore within a specified perimeter, for a specified mineral and for a specified duration. The EEP is valid for at most five years and is renewable twice for at most five years each time. The process for an EEP includes a public inquiry, with a notice explaining the general technical measures taken in respect of environmental constraints.

Mining Production

When the prospector has demonstrated the presence of an economic deposit, he may apply for a mining right, covering a defined perimeter and mineral, called a "Mining Concession". This right is duly requested before opening the mine. The title is valid for at most 50 years, and is renewable for at most 25 years each time. The process for a Mining Concession includes a public inquiry, in the same way as for an EEP, including also an environmental protection notice.

3.3.2.3. Exploration and Production Activities

The Mining Code defines the relations between the entitled operator and the owner of the surface, and between the operator and the State.

Operator and Surface Owner

The mine operator must always try to obtain an agreement with the surface owner prior to carrying out the work but, in case of disagreement, the mining title holder is able to ask for an "administrative occupation right" for the necessary area. The mine operator always remains responsible for the damages caused by his mining activity, except where the liability of a third party is proven.

Operator and State

Before beginning exploration or production activities, the mine operator must ask for an administrative authorization. The administrative process includes an impact study and a public inquiry. The agreement of the Prefect of the department (county) defines the constraints relating to the protection of the environment, after consultation with the various government services and with the involved municipalities. The Prefect is also able to exempt the operator from authorization or to lessen the process to a simple declaration in the case of activities of minor importance and low environmental impacts.

During the operations, the administration acts as a controller of:

- Occupational safety and hygiene of the workers
- Public safety
- Environmental protection
- Good recovery of the deposit.

It is also entitled to recommend corrective measures, in case of operator fault.

Before the exploration ends or the mine closes, the operator must notify the administration; the file explains the measures to be taken to lessen or to mitigate the residual impacts of the activities. The Prefect gives an agreement in the same way as before starting the operations.

3.3.3. Licensing of Mine and Mill Projects

3.3.3.1. Concerned Operations

The opening of a mine, including the preparatory works, is subject to an approval process. For this purpose, the term mine includes the mining work itself, the surface installations (maintenance shops, etc.) and usually the mill. The same approval process also applies to prospecting operations involving earth movements bigger than 20 000 cubic metres. The modification of a licenced operation, for example a new ventilation shaft, is only submitted to a short impact study, without public inquiry.

3.3.3.2. Request File

The request file contains the following documents:

- A technical description of the project, including a schedule
- An environmental impact statement (see Table IV for more details), including a public notice
- A technical note about the extraction method, achieving the best economic recovery of the resources
- A notice about occupational safety and public health and safety
- A list of the regulations related to the public inquiry into the project and how the public inquiry fits into the agreement process.

3.3.3.3. Inquiries of the Request

The request is submitted to an administrative inquiry and, at the same time, to a public inquiry.

Administrative Inquiry

The Prefect sends a copy of the file to each concerned administrative service (Industry and Environment, Agriculture, Health, etc.), and to each concerned local municipality. The administrative services have to give their advice within one month; in case of no answer after one month, they are considered favourable to the project. The mayor of each involved municipality is allowed to give his advice at the end of the public inquiry.

TABLE IV. ENVIRONMENTAL IMPACT STATEMENT — FRENCH URANIUM MINE PROJECT

1. Initial Status:	natural resources; agriculture, forests, maritime or leisure which will be affected by the project
2. Direct and Indirect,Temporary and Permanent Effects:	wild life, flora, sites and landscapes, soil, water, air, climate, natural surroundings and biological equilibrium neighbourhood nuisances (noise, vibrations, smells, lights, etc.)
3. Reasons for choice:	other options and environmental constraints
4. Projected Measures:	to remove mitigate or counterbalance the negative consequences with a cost evaluation
5. Environmental Impact Assessment Methods Analysis:	mentioning possible technical or scientific difficulties
6. Non Technical Abstract	

Public Inquiry

The Administrative Judge appoints an Inquiry Officer or an Inquiry Panel, paid by the proponent, with the following tasks:

- Collect the observations of the public during the one month inquiry
- Inform the proponent of the public comments within eight days after the public inquiry closure
- Collect the proponent's answer within 15 days
- Prepare a final report with their own conclusions and advice about the project, at most 8 days After receiving the proponent's memorandum.

The Officer or the Panel has the right to visit the involved places, require existing documents, arrange public meetings, and decide to extend the time limit within a fortnight. The Officer or the members of the Panel are chosen from an existing list, annually updated, of persons qualified in technical areas or in environment.

The public is informed of the opening of a Public Inquiry by notices posted in each concerned place and published in local newspapers. The advertising expenses are charged to the proponent. The public is allowed to read a copy of the final inquiry report which stays for one year in each local place.

3.3.3.4. Licensing Phase

The Prefect has to make a decision within six months after receiving the completed file. His decision could be:

- Do nothing, in which case the proponent is allowed to start the operations in conformity with the proposed project
- Authorize the start of the project under the conditions specified in the report
- Extend the time span of the procedure two months, making observations and asking the proponent for complementary measures. The proponent proposes measures to mitigate the effects

of the project within the allowed time, after which the Prefect may reject all or part of the project or licence it under conditions.

3.3.4. RFEP Regulation and Licensing Process

Created in the 19th Century, the French regulation referring to the Registered Facilities for Environmental Protection was last updated in July, 1976, introducing a licensing procedure with public inquiry and environmental impact statement.

3.3.4.1. Concerned Facilities

The regulation has established a very detailed list, continuously updated, of the registered facilities, some of which could be necessary for a mine project, especially for milling operations, for example:

- Engine maintenance shop of more than 5000 square metres;
- Crushing and screening plant requiring more than 200 kW electrical power;
- Sulphuric acid plant;
- Storage for more than 250 metric tons of sulphuric acid;
- Industrial waste disposal, such as tailings ponds.

TABLE V. ENVIRONMENTAL IMPACT STATEMENT FRENCH REGISTERED FACILITY FOR ENVIRONMENTAL PROTECTION

1. Initial Status:	particularly: natural resources; agriculture, forests, maritime or leisure, properties and cultural factors which would be affected by the project
2. Direct and Indirect, Temporary and Permanent Effects:	wild life, flora, sites and landscapes natural surroundings and biological equilibrium, neighbourhood nuisances (noise, vibrations, smells, lights, etc.), agriculture health and public safety, properties and cultural factors
3. Origin, Kind and Importance of the Disadvantages:	particularly with regard to air, water or soil pollution, waste, quantity and polluting character of materials, noise levels, vibrations, water supplies and uses
4. Reasons for Choice:	other options and environmental constraints
5. Projected Measures:	to remove, mitigate or counterbalance the negative consequences, detailed description and waited results, particularly relating to groundwater protection, liquid and gaseous wastes treatment, waste disposal, supplies and product transport
6. Site Remediation:	in the case of quarries and waste disposals
7. Environmental Impact Assessment Methods Analysis:	discussing the technical or scientific difficulties
8. Non Technical Abstract	

3.3.4.2. Request File

The file contains:

- A technical description of the facility, including maps, plans, etc.;
- An environmental impact statement (see Table V for details), including a notice for public information;
- A risk analysis with a description of contingencies and consequences, preventive and corrective measures and emergency organization;
- A description of occupational health and safety.

3.3.4.3. Inquiry for the Request and Licensing Phase

The process framework is much the same as for a mine, with the following differences:

- The overall process duration is not defined by the regulation;

- The Prefect has to fix the dates of the Public Inquiry within two months after receiving the application and deciding if it is complete, but there is no deadline to the control stage;

- The overall duration of the public inquiry, including the final report of the Officer or the Panel, is nine weeks, extendible for two weeks;

- The Prefect has three months after receiving the final report for delivering or refusing his agreement, but he is allowed to extend the deadline without fixed duration

- The Prefect may ask the proponent to have an external expert review his file, in which case the expert is chosen with the agreement of the Administration, but reports to the proponent;

- Before licensing, the Prefect has to ask the advice of the department (county) health council;

- The agreement can never be tacit; it is always an administrative document which prescribes the operations, particularly concerning releases, waste management, site monitoring, and the safety organization.

3.3.4.4. Modifications of a Licensed Facility

The modification project is reviewed by the Inspection of Registered Facilities and, depending on the potential impacts, the Prefect is entitled to make complementary recommendations or to require the proponent to apply for a new authorization, involving a complete licensing procedure.

3.3.4.5. Practical Applications

The mine or mill project applications must contain detailed, rather than conceptual designs. The level of detail depends on the size and importance of the environmental effects. It also depends on the knowledge of the future activity, which is generally better in the case of a mill or an open pit than in case of an underground mine. Furthermore, a mill project involves one or more Registered Facilities and sometimes starts a few years after the mine opening. For these reasons there are generally two licensing processes, one for the mine and an other for the mill, a few years after, taking into account RFEP regulations. Practically, French administration tries always to reduce the number of processes relating to a project.

The first step in a licensing process is discussion with the DRIRE administration, which manages both procedures. This familiarizes the administration with the project and enables it to defend the final project against the other administrations.

This process is the best way to avoid errors and to achieve the best compromise between technical or economical and environmental constraints. This is usually possible because of the skill of the DRIRE inspectors in regulatory matters and mining techniques, their intellectual integrity and their sense of responsibility. This is important when regulations are not perfectly clear and not without contradictions, and when there is a lack of standards. Such is the case in France concerning chloride and sulphate releases into streams and when a standard is technically not achievable.

The DRIRE administration manages the whole Administrative Inquiry under the direction of the Prefect; it presents and explains the project to the other administrations; and it is responsible for drafting the technical recommendations of the licence.

The Public Inquiry is managed by the Administrative Court, which chooses the Officer or the Panel. The selection criteria are more related to administrative competencies than to technical skill.

3.4. SOUTH AFRICA

Since 1952 uranium production in South Africa has occurred as a by-product of gold and copper mining activities. The need to draw up formal integrated Environmental Impact Assessments (EIAs), Environmental Management Programme Reports (EMPRs) and Environmental Management Programmes (EMPs) with regard to mining activities is a relatively new one for the mining industry. The present regulatory approach in South Africa should be regarded as an evolving process, with the aim of ensuring greater accountability and transparency in terms of the proponents proposals and responsibilities and ensuring that the public is adequately informed about the impacts and has input into the approval process for new mining operations.

3.4.1. Legislation and Regulatory Approach

Mining and prospecting activities in South Africa are subject to the requirements of many different acts of legislation implemented by a number of nationally based regulatory organizations. Therefore requirements pertaining to an EIA for a uranium mine and mill project would be addressed by several sets of legislation.

A number of regulatory organizations are involved in implementing legislation concerned with the "non radiological" aspects of mining e.g. prospecting, mineral rights, planning, health and safety, hazardous waste, water quality, rehabilitation, EMPs, mine closure, mine safety, etc.

The present environmental assessment requirements set down by the Government Mining Engineer (Department of Mineral and Energy Affairs) are applicable to most types of mining activities; specific EIA requirements have not been set down for uranium producing operations.

Mining and prospecting operations must comply with the requirements of the Minerals Act No 50 of 1991, which requires that mines submit and obtain approval for an EMP.

A number of guidelines have been issued by the Department of Mineral and Energy Affairs to assist mine operators in drawing up an EIA and completing the requirements of an EMPR, e.g.

- The Aide-Memoire for the Preparation of Environmental Management Programme Reports (EMPRs) for Prospecting and Mining

- Standard Environmental Management Programme for Prospecting
- Manual for the Construction, Operation, Pollution Control, Rehabilitation, Decommissioning and After Care of Gold Tailings Dams in South Africa

The Aide-Memoire was drawn up by an Inter-departmental Liaison Committee comprising representatives of the mining industry and the relevant regulators e.g. Departments of: Mineral and Energy Affairs, Water Affairs and Forestry, Agriculture, Environmental Affairs, National Health and Population Development, Finance, etc.

The purpose was to assist applicants for, and holders of, prospecting permits or mining authorizations to draw up EMPRs in accordance with an established approach acceptable to the involved regulatory authorities and to secure their approval of the report.

The submitted EMPR must meet the following objectives:

- The environmental requirements and directives under the Minerals Act, No 50 of 1991, and its regulations.
- To provide a single document that will satisfy the various authorities concerned with the regulation of the environmental impacts of mining.
- To give reasons on the need for and overall benefits, of the proposed project.
- To describe the relevant baseline environmental conditions at and around the proposed site.
- To describe the prospecting and mining method and associated activities so that an assessment can be made of any significant impacts that the project is likely to have on the environment during and after mining.
- To describe how negative environmental impacts will be managed and the positive aspects of the project maximized.
- To set out the environmental management criteria that will be used during the life of the project so that the stated and agreed land capability and closure objectives can be achieved and a closure certificate can be issued.
- To indicate that resources will be made available to implement the EMP.

The EMPR and the EMP are intended to be site specific: therefore the requirements of the Aide-Memoire are applied as appropriate in a site specific manner. The EMPR is to be seen as a dynamic document which may require updating during the life of the project. The impact management activities should be based on the concept of Best (Proven) Available Technology Not Entailing Excessive Cost (BATNEEC).

In the case of operating mines the assessment should be concerned with establishing the actual impacts of the mine on an environment in which development has taken place. Wherever a significant impact has been identified by the EIA the proponent must describe how the impact will be managed through the EMP which must be approved by Mineral and Energy Affairs: once approved the EMP becomes legally binding. Since the approved EMP is legally binding on the mine owners, it must be complied with if a closure certificate is required at the end of mining operations.

In the case of those mines handling radioactive ores, before a closure certificate could be issued in terms of the requirements set down in the EMP, the requirements of the CNS in terms of the site licence would also have to be complied with.

The standard approval process outlined above may be modified in the case of sensitive environments or designated areas or features e.g. protected natural areas, estuaries, lakes beaches etc. In these cases a more lengthy and comprehensive evaluation process may be instituted with significant public and government input.

Specific additional legislation has been developed since 1948 for those mines exploiting ores containing uranium. In terms of the radiological aspects of an EIA associated with uranium deposit development, these would be defined and determined by the Council for Nuclear Safety (CNS) in accordance with the requirements of the Nuclear Energy Act (Act No 131 of 1993).

In addition to the requirements of the Aide-Memoire, a new uranium deposit development would require to demonstrate that it would comply during its operating lifetime with the CNS fundamental safety standards. Compliance with these standards would have to be demonstrated through a prospective hazard assessment.

If compliance with the standards was demonstrated then the CNS would be obliged to issue a licence to allow construction and operation of the facility in accordance with site specific licence conditions set down by the CNS.

3.4.2. EMPR Case History

The following contents summary is taken from a case study based on an underground gold mine that has mined gold for over 100 years and produced uranium for some 30 years.

The case study and contents closely follows the complete requirements of the Aide-Memoire on EMPRs issued by the Department of Mineral and Energy Affairs. Radiological assessments are usually submitted separately to the CNS, though an overview may be included in the EMPR.

The amount of information submitted will vary from site to site and will also depend upon the size of the mine, the variety and extent of mining and metallurgical operations carried out at the site, the stage of development and the extent of the impact of the project on the surrounding area, population and environment

The following summary lists the topics of interest and provides some comment on the amount and type of information required.

3.4.3. Environmental Impact Assessment (EIA)

The EIA forms part of the EMPR and is the basis for determining the scope and nature of the required EMP: the various environmental impacts associated with the identified mining and ancillary activities can be classified as follows:

- Positive impacts
- Significantly negative impacts
- Marginally negative
- Negligible impact

In addition to the above classification, the magnitude, timing and duration pertaining to the manner in which the various activities impact on each environmental unit should also be documented. It should be noted that the assessed impacts may in many cases be expressed in a non quantitative and subjective manner. Where impacts are of a transient nature this should be indicated, e.g. decommissioning and closure phases, where the impact may be negative in the short term but positive in the long term.

3.4.4. Contents of the EMPR

3.4.4.1. Part 1: Introduction and Project Overview

Description of: mine location, mineral rights and mineral lease agreements, tribute agreements, mining authorizations, land ownership, surrounding localities, towns, infrastructure, presence of servitude, land tenure and use, use of adjacent land, river catchment, the project, mineral deposits, mine products, estimated reserves, mining methods, production strategy and planned output, projected life of the mine.

3.4.4.2. Part 2: Description of the Mining Environment

The following aspects of the site and environs are described:

Regional and general geology, gold reef horizons, presence of faults, sills and dukes extending beyond the property. Prevailing climate, regional climate, monthly, annual and maximum rainfalls, temperatures, wind direction and speed, monthly evaporation, weather extremes.

Topography, soil structure, type and condition and underlying geology. Pre-mining land use, current state of property compared to historical records on previous use and misuse. Land capability and use: historical agricultural production, agricultural production, evidence of misuse, erosion, existing structures. Natural vegetation: original type, present status of plant community, dominant species, endangered or rare species, invaders and exotic species; revegetation programmes e.g. slimes dams. Animal life: commonly occurring, endangered or rare species.

Surface water quantities and qualities: Identify, list and describe the catchment boundaries and their mean annual run off, drainage densities, dry weather, peak and flood volume flows, river diversions, local and regional water authorities, surface water use, presence/absence of wetland's and their significance. Sample surface waters on and off the site for conductivity, pH, and contaminants, e.g. dissolved solids, sulphate, iron, calcium, sodium, potassium, magnesium, nitrate/nitrite, silica, phosphate, chloride, alkalinity, dissolved oxygen, iron, chromium, ammonia, lead, manganese, aluminium, nitrogen.

Groundwaters: identify and characterize the depth and state of water tables, the presence of boreholes and springs, the extent and nature of groundwater use, the influence of mine waters and flooding in underground areas. Sample groundwaters on and off the site to determine water quality and extent of mine pollution impact.

Air Quality: identify and quantify impact of sources of air pollution on the site, e.g. dusts.

Noise: perform noise survey on the site and adjacent areas.

Sites of archaeological and cultural interest: identify presence/absence and impact of mining operations. Sensitive landscapes and visual aesthetics of the site: identify presence/absence and impact of mining operations.

Regional socio-economic structure: quantify and characterize the population density, growth and location, economic activity and employment levels, unemployment levels, housing density, social infrastructure, water and power supply in areas adjacent to the site.

Interested and affected parties: this section is not required for operating projects and is primarily intended for inclusion in the EMPR for a new project.

Background radiation levels: assessment of radiation hazards would normally be included in separate reports submitted to the CNS. A background survey would be carried out to determine levels existing prior to mining activities.

3.4.4.3. Part 3 Motivation for the Project

This section is only required for proposed projects; no motivations are required for existing projects.

3.4.4.4. Part 4: Detailed Description Of the Project

Part 4.a: Surface Infrastructure

For the surface infrastructure a more detailed description is drawn up on the following items: road, rail and power lines, solid waste management facilities, mine residues, residue disposal sites, water pollution management facilities, sewage plants, pollution control dams, polluted water treatment facilities, potable water supplies, process water. A general description is given of the mineral processing plant, workshops, administration and other structures e.g. housing, recreation and other facilities.

For the transport an identification of local transport facilities is requested.

A quantitative water balance diagram and explanation is drawn up for the whole site: identify disturbance of water courses, storm water drainage and characteristics, define 50 year floodlines.

A description of the construction phase is requested for new projects.

During the operational phase if is requested to investigate and report on soil utilization guide: mine surface layout (access to workings, effect of blasting vibration on surface structures, location, extent, depth and potential for surface subsidence), effects of surface subsidence.

Part 4b: Mining Plan

Describe the mining plans and quantify activities e.g quarterly returns on mining activities.

Part 4c: Mineral Processing

Describe processing methods employed on the site

Part 4d: Plant Residue Disposal

Describe and quantify e.g. slimes and waste rock

Part 4e Transport

Describe transport of products

Part 4f Proposed River Diversions

Describe any proposed river diversions

3.4.4.5. Part 5: Environmental Impact Assessment

The impacts associated with the mining activities on each identified environmental unit are reported in this section.

Part 5a Construction Phase

The environmental impact of any present and future construction activities would be described and discussed in this section.

Part 5b Operational Phase

The impact of mining activities on the following aspects and units of the environment are described and assessed.

Geology, topography, soils, land capability, land use, natural vegetation, animal life, surface water (de-deterring volumes, polluted water volumes; potential for and consequences of flooding; river diversions), groundwater, air quality, noise, sites of archaeological and cultural interest, sensitive landscapes and visual aesthetics, regional socio-economic structure, population density, growth and location, economic activity and employment, unemployment, housing, social infrastructure, water and power supply, interested and affected parties.

Radiological hazards are usually reported separately from the EMPR.

Part 5c Decommissioning Phase

The impact of any site decommissioning activities on all the aspects and units of the environment considered under the operational phase are described and indicated.

Part 5d Residual Impacts After Closure

This section is largely concerned with indicating the potential for continued contamination of surface and groundwaters, the potential for dust emissions and the stability of dump deposits.

The following aspects are usually considered and reported on:
Long term impact on surface and groundwaters, potential for and quality of mine leached, long term stability of rehabilitated ground and residue deposits, long term impacts arising from river diversions and long term impacts on wetlands.

3.4.4.6. Part 6: Environmental Management Programme

The reported programme will largely be concerned with managing and reducing the significance of the negative environmental impacts resulting from past and ongoing mining practices identified in the EIA. On older mines nearing the end of their productive life those aspects relating to managing the negative impacts resulting from activities related to decommissioning, rehabilitation and closure will assume greater importance than is the case in operating mines e.g. closure objectives, long term maintenance of residue deposits such as slimes dams, financial provisions and long term rehabilitation costs.

Later sections of an EMPR may include as appropriate the following sections:

- Part 7. Conclusions
- Part 8. Statutory Requirements, e.g., Nuclear Licences
- Part 9. Amendments to the EMPR
- Part 10. References and Supporting Documentation, e.g., technical assessments and reports
- Part 11. Confidential Material, e.g., material of economic and commercial sensitivity
- Maps and Plans

Suitably scaled maps, plans and lists would be included on the following aspects as appropriate for each site:

Locality maps
Regional geological plan
General geological plan
Geological section of the reef (lithostratigraphic subdivisions)
Faults and dyke plans on the mine and adjacent property

Principle freehold land ownership
Mineral rights holders
Windrose data
Topographic plan
Surface rehabilitation areas
Soil plan
Land use plan
Vegetation plan
Surface water plan
Water balance diagram
Mine water compartments
Groundwater model and levels
Radiation surveys (isodose contour maps: activity levels in soils)
Plant plans, process flow sheets and site layout
Slimes dams, waste rock dumps
Underground mine plan
EIA: matrix chart
Proposed rehabilitation measures
Aerial photographs of the site, facility and surrounding areas.

A list of abbreviations and a glossary would also be appropriate to include in the EMPR.

3.5. UNITED STATES OF AMERICA

Regulation and licensing of uranium mining and milling in the United States of America, including ISL mining, rests with the US Nuclear Regulatory Commission (NRC) and with the appropriate state agency where the project is located. This section will discuss only the NRC (federal) process since the individual state regulations covering uranium mining vary considerably from one state to the next. The NRC receives its authority for regulating uranium mining under the National Environmental Policy Act (NEPA, 1969) and other laws. The NRC is required to license, control and monitor all facilities that produce source material (natural uranium). The NRC also regulates the radiation health and safety of the mine and mill workers, and ensures that the public is not exposed to abnormal levels of radiation as a result of the mining or milling activities at a uranium mine.

The NRC, using the regulations established under NEPA, conducts an environmental assessment of each conventional uranium mill and each ISL mine proposed for development. This assessment process requires the proponent to prepare an Environmental Report (ER) that documents the pre-mining (baseline) environmental conditions, describes the mining plans, assesses the impacts, describes the operational and post-mining environmental monitoring program, and presents a decommissioning plan. The public is notified of the proposed project and the ER is made available for public examination. Once the NRC has received and reviewed the ER, it has two possible courses of action. It can decide that the potential environmental impacts are minimal and manageable, and proceed with issuing the Source Material License. On the other hand, if the NRC feels that the impacts from the proposed project might be significant, it can require the proponent to go through the full Environmental Impact Statement (EIS) process, which is described in the following paragraph.

The EIS process provides for the preparation and submission of the ER by the proponent as described above, followed by a public scoping meeting held in a community near the project site. The public meeting is designed to gather input from private citizens and other government agencies on which environmental issues relative to project are the most critical and need emphasis in preparation of the EIS. Based on the scoping meeting, the NRC may require the project proponent to conduct additional environmental studies and/or supply additional project information on the mining or decommissioning plans. The NRC then contracts an independent third party to prepare an EIS, using the ER and other information supplied by the proponent. The firm preparing the EIS may also conduct additional environmental studies or collect additional baseline information, if it feels this is necessary. The cost of preparing the EIS and collection of any additional information is paid by the project proponent.

The NRC first issues a Draft EIS and distributes it to interested parties, such as other government agencies. It also makes the Draft available to the public for review and comment. Based on the comments received from all parties, the NRC then completes and issues the Final EIS, and makes it available to the public. Following the public comment period, the NRC can either reject the project or issue the Source Material License, with or without written conditions. The license conditions typically specify certain monitoring and reporting requirements, and may also dictate decommissioning objectives.

The majority of the ISL uranium mines in the United States of America licensed over the past 20 years have not had to go through the NRCs full EIS process. There is presently only one proposed ISL mine, located in New Mexico, that is in the licensing stage of development. The NRC is requiring this mine to go through the full EIS process and the Draft EIS has been issued. After an application for a Source Material License is submitted, it can take from six months to over two years for final approvals to be issued by the NRC.

The producing ISL mine most recently licensed by the NRC is the Crow Butte mine located in the state of Nebraska. The NRC did not require this mine to go through the full EIS process. Instead, the NRC issued the operating Source Material License based on the ER submitted by the applicant. The license is some 11 pages long and contains over 56 license conditions. A copy of page 1 of the license is included as Appendix VII. Source Material licenses must be renewed every five years. The ISL mining industry would like to have the NRC Source Material License issued for the life of the project. The industry rationale for life of mine licensing is that the law requires that existing licenses be kept current through the amendment submission and approval process, which requires that any changes in the process and changes in the mine or decommissioning plans be approved in advanced. Approved amendments are incorporated into the Source Material License.

The following documents are important for the environmental licensing process for ISL uranium mines in the United States of America.

- USNRC Regulatory Guide 3.46 — "Standard Format and Content of License Applications, Including Environmental Reports, for In Situ Uranium Solution Mining",

- USNRC Regulatory Guide 3.8 — "Preparation of Environmental Reports for Uranium Mills",

- Council of Environmental Quality — "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act" (40CFR1500-1508),

- State of Wyoming, Department of Environmental Quality — "In Situ Mining Regulations" (Chapter XX).

4. MODEL ASSESSMENT AND LICENSING PROCESS

4.1. GENERAL

Environmental impact assessment is one part of the licensing process for a uranium mine and mill development. This chapter identifies and discusses key characteristics of the assessment process and shows how these would fit into a model licensing process.

4.2. KEY CHARACTERISTICS

The key characteristics of an ideal environmental assessment process are:

- Single process satisfying interests of all levels of government;
- Clear terms of reference for the process;
- Strong leadership in the assessing body (commission, panel, etc.) to keep to the terms of reference;
- Appropriate level of assessment;
- Mutually agreed guidelines for the contents of the EIS;
- Practical and reasonable requirements on the proponent;
- Appropriate level of detail required by the guidelines;
- Reasonable schedule, strictly adhered to;
- Opportunity for public input;
- Not overly burdensome financially;
- Not dealing in detail with issues that are already the subject of existing acts, regulations, codes, etc.;
- Predictable;
- Fair in that all proponents are treated equally.

4.3. SINGLE ASSESSMENT PROCESS

In many countries there are a number of government agencies at the federal, state and local levels that have an interest in the approval of a uranium project. In some cases a single agency has been given the responsibility for environmental assessment. The proponent should not be subjected to multiple and variable assessment processes for a single project, but rather a single coordinated assessment process should be used to satisfy the interests of all of the agencies.

4.4. TERMS OF REFERENCE

The terms of reference for the assessment process should be developed by the competent authority with the co-operation of other interested government agencies. The terms should clearly state who does the assessment, the subject areas to be examined in the assessment, the general conduct of the assessment, and the schedule for the assessment. Development of generic terms of reference would be an advantage in countries that are anticipating more than one project.

4.5. LEADERSHIP

It is essential that the assessment body have strong leadership It is important for the efficient functioning of the process that the assessment body be focused on the matters required by the terms of reference. This becomes even more important if the process proceeds into public meetings of hearing. Opponents of a project should be permitted to delay or confuse the assessment introducing issues that lie outside the terms of reference.

4.6. APPROPRIATE LEVEL OF ASSESSMENT

Care must be taken in setting the terms of reference and in developing the guidelines for the EIS to demand a level of effort which is appropriate to the scale and anticipated impact of the project. A small project could become completely uneconomical if the terms of reference for the assessment are too broad and require a level of detail which is not commensurate with the impact potential.

4.7. EIS GUIDELINES

The EIS guidelines should be developed by the technical experts from the assessment body and the proponent. Public input to the guidelines is recommended to ensure that the EIS addresses issues that the public deems to be important. The various agencies with an interest in the project should have input to the guidelines. However, care must be taken to ensure that the guidelines conform to the constraints of the terms of reference. In addition it must be recognized that the EIS is not a vehicle for performing fundamental environmental research. The guidelines must require that the EIS develop sufficient information to permit a proper assessment of the project, but they should not demand excessive detail about issues which are not important. Development of generic guidelines would be an advantage in countries anticipating more then one project.

Environmental impact assessment is usually one step in the licensing process for a uranium mining and milling operation. Many other matters, such as details of construction and operating procedures, may need approval before an operating licence is granted by the competent authority. Details of construction, for example, would be covered in building codes or regulations and, consequently, there is no need to examine detailed plans as part of the environmental assessment. The EIA should constrain itself to an examination of areas where the proposed project could have a significant effect on the surrounding physical, biological and socio-economic environment. It should be recognized that it is not essential to examine every trophic level of the ecological environment, but rather to examine indicator species and species of economic and cultural importance.

4.8. SCHEDULE

The proponent of a mining project generally has a large investment in the project before the completion of the environmental assessment and this investment becomes even larger through the construction period. No returns are received until product is sold, which can be many years after the initial exploration work. For the proponent to remain solvent and satisfy his shareholders, it is essential that the schedule be reasonable and that the assessment process adhere to the schedule.

If the project is in an area where there has been no previous development, then a four-season baseline study is warranted. However, if the project is an extension of an existing one or, as often happens with mining projects, in an area which has already undergone considerable development, there will likely be a large base of environmental data already in existence, which should be employed to shorten the study period.

Regardless of the time required for the environmental studies for the EIS, the other parts of the process can be fairly rigidly scheduled. The competent authority should respond quickly and efficiently when the project is proposed, and the assessment body should act quickly to develop the guidelines after it is appointed. This should be accomplished in four months, or less including public input. After receipt of the EIS, the assessment body should move quickly to review the document and seek public comment. The complete process from the receipt of the EIS to the issue of the recommendations from the assessment body should be accomplished in less than one year, including public input.

4.9. PUBLIC INPUT

It is rare that a project be proposed in an area with no public interest. Often the reverse is true, with many different publics (local community, national population, special interest group) expressing interest, particularly in uranium projects. It is not uncommon for a mining company to be exploring in an area for many years before identifying a viable project. Advantage should be taken of this time to establish good relations with local residents. Public input should be sought early in the project, preferably when the guidelines for the EIS are being developed. This will ensure that questions that are important to the public are being addressed. Public comment of the EIS should be solicited and, if public hearings are held, public participation should be permitted. However, this public input should be limited to issues which have been identified in the terms of reference. The assessment body should be prepared to explain to the members of the public why particularly issues are not open for discussion (usually because they have been covered elsewhere).

The proponent is well advised to have a public information programme. The public should be kept informed of the project and information form the EIS should be made available in the form of a non-technical executive summary. The use of audio and video tapes in local languages may be of assistance in communicating with local residents who may not fluent in the business and technical language used in the country.

4.10. PREDICTABILITY AND FAIRNESS

It is also important for the proponent to know that, if he conforms to the requirements of the legislation and meets the demands of the assessment process, that he will gain approval in a reasonable time. Without this degree to predictability, the proponent may be wasting a large investment.

Projects can be proposed in many different environments and environmental assessments by their nature must be site-specific. In some cases, local environmental constraints can prove very costly for a project. However, in examining different projects, the assessment body should apply the terms of reference and conduct the review in a fair and consistent manner.

Appendix I lists a number of factors to consider in drafting an EIS for a uranium project. The list should be viewed more as checklist than a firm recommendation to examine every topic in detail. For example, earthquakes and vulcanism are not an issue to be concerned about in northern Saskatchewan, but these are of vital.

4.11. KEY CHARACTERISTICS OF THE LICENSING PROCESS

The key characteristics of an ideal licensing process are:

- Clearly and concisely defined;
- Fair and predictable;
- Explanation of licence refusal;
- Timely responses to applications;
- Stable and pragmatic licensing environment;
- Single coordinated process;
- Assurance of operating licence process is used;
- Project lifetime licences;
- Appeal process available against regulatory decisions.

4.12. DEFINITION OF PROCESS

The licensing process should be clearly an concisely defined requiring responses to applications within a specified period of time. The process should be predictable, in that an applicant that fulfills the requirements should be assured of a favourable response. However, when an application is not satisfactory, the competent authority should explain the shortcomings to the applicant. An appeal process should be available to the applicant or licensee against what he deems to be unfair treatment at the hands of the regulatory authorities.

4.13. SINGLE PROCESS

Although in many countries there are several agencies and several levels of government that have a legitimate interest in the licensing of uranium projects, it must be recognized that multiple approvals. A proponent should not be expected to waste resources in dealing with the same issues from slightly different perspectives to satisfy the requirements of different agencies. Hence, the ideal licensing process is a single process, which responds to the demands of all the agencies with an interest in the project through a single coordinated set of licensing criteria leading to a single operating licence. Similarly, the process should be the same for all applicants.

4.14. PERIOD OF LICENCE

Although it is preferable to grant a single licence covering all aspects of the project (siting, construction and operation) it is recognized that circumstances may demand a staged approach to licensing. In such cases, the preferred approach is to grant a single licence with conditions which require the completion of specific outstanding matters by the applicant before operations can start. If the licence is not granted in this fashion, then the applicant must be assured at the construction licensing stage that he will ultimately receive an operating licence.

Licences should be granted for the life of the project, unless a major infraction of licence conditions or laws occurs. Changes to the conditions of the licence can be negotiated when required by reason of changes in the nature of the project or in the environment within which the project operates.

4.15. RECOGNITION OF DUTIES AND RESPONSIBILITIES

On receiving a licence, a proponent must recognize that the licence conditions define his legal responsibilities, and that it is the function of the competent authority to ensure compliance with the licence conditions.

4.16. REGULATORY AUTHORITIES

A regulatory authority is a legally constituted body with clearly defined powers and responsibilities in a particular area of law.

Within a particular area of law and legislation, e.g. environmental law, a number of different regulatory authorities may operate nationally, provincially or locally, or at all three levels. Their powers and responsibilities may, therefore, be widely different. Ideally all regulatory authorities within a particular area of enforcement should follow a similar regulatory approach and operate in a consistent manner.

4.16.1. Roles and Responsibilities

The most important role of a regulatory authority is to enforce the requirements of the law. In addition it must ensure that the enforcement is carried out in an even-handed and consistent manner.

With regard to the EIA process and the EIS review the main roles and responsibilities of the regulatory authority are:

- To ensure that the requirements of the relevant legislation are complied with by the proponent or licensee.

- To ensure that the process is clearly define set down and involves a minimum of delay in the review and decision making process.

- To develop written terms of reference defining the scope and requirements of the EIA and guidelines for the EIS, which ensure that the EIA adequately assesses and quantifies all relevant impacts on the environment in both the short and long terms.

- To clearly define the criteria against which the EIS will be assessed, to ensure standardization of the review and decision making process.

- To adequately assess the proponent's and licensee's submissions and to ensure that suitably qualified and experienced personnel are available to do this in a timely manner.

- To ensure adequate public input into the review process.

- To document the relevant site specific licence conditions to be applied during operation, decommissioning and reclamation, that will ensure compliance with the legislation and the recommendations of the EIA.

- To clearly define the relevant standards against which licensee compliance is assessed.

4.16.2. Legal Powers and Limitations

The legal powers and limitations of the competent authority must be clearly defined in legislation. Once a decision is made to accept a proposal, the project should be licensed to ensure legal compliance by the licensee with the relevant conditions and standards. Compliance with these licence requirements would then be legally binding on the licensee. It is the responsibility of the competent authority to ensure that the licensee demonstrates compliance with the licence conditions.

Limitations on the powers of the regulators should be clearly defined in the legislation and an appeal process against regulatory decisions should be available. This appeal process may be to a higher authority, to an independent adjudicator or through the courts.

4.16.3. Rationale for Environmental Laws and Regulations

The aim of environmental law should be to protect the environment and public interests both in the short and long terms in a manner that is consistent with the economic needs of society and ensures the long term preservation of the environment as an ecologically intact and properly functioning unit which sustains the long term survival of mankind.

Modern societies rely heavily on laws and legislation to define their structure and direct their function. Regardless of the manner in which different nations go about organizing and implementing their legislative and legal systems, it is of primary importance that laws are written a clear and unambiguous manner. Good laws use words that have precise and agreed meanings and have clearly defined aims and terms of reference. This is of particular importance for legislation in areas with a significant technical component, such as environmental law. When drafting environmental legislation, it is essential that it be both technically and legally correct, and unambiguous in its intent and expression. Therefore, when drafting legislation, it is vitally important that adequate technical expertise be available to review the draft legislation at all stages up to its final approval.

In addition, where legal responsibilities in a particular area are implemented by a number of different regulatory authorities (e.g. environmental law), it is essential that, when new legislation is drafted, all regulatory authorities have input into the drafting and review process. This is essential in order to eliminate overlap, contradiction and confusion in different sets of legislation. Ideally the number of regulatory authorities involved in protecting the environment should be minimized to ensure a holistic and integrated approach to the law and its implementation. National and provincial legislation should also be mutually compatible and consistent, and share the same goals and methods of achieving these goals.

When defining the legislative requirements, consideration should be given to ensuring that the required laws can be effectively. In order to ensure that this is the case, an adequately funded and suitably staffed regulatory authority, independent of any outside vested interests, must be set up.

The regulatory authority must be seen to operate in an open, consistent and even-handed manner. In addition, it must ensure that proponents and licensees are meeting the objectives of the legislation and complying with the law. All decision making processes must be transparent and involve all the parties with legitimate interests.

Regulators may implement the requirements of the law through regulations or licences or a combination of both. Regulations are often required to cover all conceivable site and operating conditions, whereas licence conditions can be specific to each site.

APPENDIX I — FACTORS TO CONSIDER IN DRAFTING AN EIS

I.1. GENERAL

Earthquake probability and severity
Vulcanism
Major fault zones
Regional climate
Flood plains
Maximum precipitation

I.2. ENVIRONMENTAL BASELINE

Topography
Geology
Surface hydrology
Hydrogeology
Flora
Fauna
Endangered species
Background concentrations of trace metals and radionuclides
Local waters
Local sediments
Local surface soils
Local biota

I.3. GENERAL CONSIDERATIONS FOR CONVENTIONAL MINING

Waste rock management
Acid generation
Metals leaching
Infiltration of precipitation
Dusting
Radon exhalation
Re-vegetation
Groundwater contamination
Mine water quality, treatment and disposal
Trace metals in ore and waste rock
Ground stability
Ore stockpiles:leached
Run-off
Dusting
Radon exhalation
Contaminated equipment

I.4. FACTORS SPECIFIC TO AN UNDERGROUND MINE

Subsidence
Ventilation
Mine air exhausts-dust emissions
Radioactivity emissions
Mining methods
Use of backfill

I.5. FACTORS SPECIFIC TO AN OPEN PIT MINE

Mine de-watering impacts
Air emissions-dust
Radioactivity

I.6. MILL
Effluent treatment and quality
Tailings management-dam stability
Leached quality and quantity
Dusting
Radon exhalation
Air emissions-crushing and grinding
Product drying and packing
Fire hazards
Hazardous chemicals
Contaminated equipment

I.7. IN SITU LEACH PROJECT
Hazardous chemicals
Air emissions
Groundwater contamination
Liquid wastes
Contaminated equipment
Radiation hazards

I.8. TRANSPORTATION
Ore spills
Chemical spills
Product spills
Highway traffic accidents
Potential for water pollution
Potential for air pollution
Public safety
Fire hazards
Radiation hazards

I.9. SOCIO-ECONOMICS
Local population
Employment/livelihood
Cultural issues
Archaeology/history
Benefits of project

I.10. CUMULATIVE IMPACTS, WHERE MULTIPLE PROJECTS ARE GOING FORWARD IN ONE AREA

APPENDIX II — ECOLOGICAL RISK ASSESSMENT

To efficiently development an environmental impact statement, factors should be screened for impact potential, which will then allow the study effort to be put into areas of potentially significant impact. Ecological risk assessment is a useful tool for evaluating the importance of various factors to the environmental assessment. The process identifies potential undesirable ecological impacts, estimates the probability of their occurrence and evaluates the ecological consequences of such impacts, should they occur.

To perform this type of analysis Valued Ecosystem Components (VECs) must first be identified. These may be important for the functioning of the ecosystem, they may be important sources of food for subsistence or they may have cultural, medicinal or scientific significance. It is helpful to get the opinions of local people in identifying the VECs. Endpoints for defining risk to these VECs are established, e.g. in terms of chemical toxicity or radiation dose. Environmental concentrations of the various contaminants to be emitted by the project are conservatively estimated using environmental pathways modelling. Primarily from the literature on laboratory experiments, benchmark toxicity levels are established, which would result in known effects. A screening index is established by dividing the estimated exposure from the pathways modelling by the benchmark value. If the index is greater than one, it indicates that a potential risk exists and that more detailed investigation is required.

This technique can identify those components in the baseline environment and those emissions from the project, which are deserving of the greatest attention in monitoring programmes or in designing mitigative actions. However, it must be recognized that there is uncertainty in the risk assessment, arising from uncertainties in the degree of emission toxicity to the VECs and from the range of emission rates. The modelling deals with uncertainty by performing a Monte Carlo calculation, resulting in probable impacts.

It is also important to remember that ecological risk analysis does not look at all the factors, because some are not amenable to quantification in a manner which can easily be handled in the computer analysis. An example would be the degree of surface disturbance, which could affect the prevalence of particular animals in the project area. A question which would have to be addressed would be whether simple avoidance of the disturbed area would have any detrimental impact on the local wildlife.

APPENDIX III — TABLE OF CONTENTS OF DRAFT EIS

APPENDIX IV — TABLE OF CONTENTS FOR EIS GUIDELINES — DEILMANN TAILINGS PROJECT KEY LAKE, SASKATCHEWAN, CANADA

1. INTRODUCTION

2. PROJECT DESCRIPTION
   - Project Concept
   - Tailings Disposal Method
   - Tailings Characterization
   - Tailings Disposal Site
   - Infrastructure

3. DESCRIPTION OF EXISTING ENVIRONMENT
   - Environmental Database
   - Geology and Hydrogeology
   - Climate, Meteorology and Air Quality
   - Surface hydrology and Water Quality
   - Aquatic and Terrestrial Ecology

4. SOCIO-ECONOMIC ISSUES

5. OCCUPATIONAL HEALTH AND SAFETY

6. PUBLIC INVOLVEMENT

7. IMPACT ASSESSMENT AND MITIGATION
   - Regional Context
   - Project-Specific Impacts
8. MONITORING
9. DECOMMISSIONING, RECLAMATION AND ABANDONMENT

10. SUMMARY

APPENDIX V — TABLE OF CONTENTS OF EIS — DEILMANN IN-PIT TAILINGS MANAGEMENT FACILITY KEY LAKE, SASKATCHEWAN, CANADA

APPENDIX VI — TABLE OF CONTENTS OF EIS — COLLINS BAY A-ZONE, D-ZONE AND EAGLE POINT DEVELOPMENT RABBIT LAKE, SASKATCHEWAN, CANADA

Training
- Introduction
- Orientation of New Employees
- Radiation Protection Training
- Occupational Health Safety
- First Aid
- Fire
- Job-Related Skills

Environment
- Introduction
- Environmental Monitoring
- Routine Environmental Inspections

3. PROJECT DESCRIPTION

Introduction

Geology
- Regional Setting
- Surficial Geology
- Bedrock Geology
  - Pre-Wollaston Group gneiss
  - Wollaston Group
  - Athabasca Group

Structure
- Introduction
- Collins Bay Fault
- Eagle Point
- Healed breccias

Alteration

Mineralization
- Introduction
- Collins Bay A-zone
- Collins bay D-zone
- Eagle Point

Ore Reserves

Hydrology
- Introduction
- Field Investigations
  - Drilling programme and lake bottom soundings
- Subsurface conditions: Collins Bay A-zone
  - Introduction
  - Organic Silt
  - Boulder pavement
  - Silt
  - Sandy till
  - Fault zone
  - Athabasca sandstone
  - Athabasca paragneiss
- Subsurface Conditions Collins Bay D-zone
  - Introduction
  - Organic Silt
  - Sand and silt
  - Boulder pavement
  - Silty sand till
  - Sand
  - Fault zone
  - Athabasca sandstones
  - Aphebian paragneisses
  - Granitoid basement (Pre-Wollaston Group gneiss)
- Ground-Water Seepage
  - Introduction

NRC FORM 374 (10-89)

U.S. NUCLEAR REGULATORY COMMISSION

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MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954 as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 39, 40 and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below, to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee		
1. Crow Butte Resources, Inc. [Applicable Amendment 24]	3. License number	SUA-1534, Amendment No. 24
2. 216 Sixteenth Street Mall, Suite 810 Denver, Colorado 80202	4. Expiration date	January 1, 1996
	5. Docket or Reference No.	40-8943

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
a. Natural Uranium	Any	a. 454,545 kg
b. Byproduct material as defined in §11e(2) of Atomic Energy Act of 1954, as amended.		b. Quantity generated under operations authorized by this license.

9. Authorized place of use shall be the licensee's Crow Butte facilities in Dawes County, Nebraska.

10. For use in accordance with statements, descriptions, and representations contained in Sections 3.0, 4.0, 5.0, and 6.0 of the licensee's Environmental Report submitted by cover letter dated October 7, 1987; as revised by page changes submitted on December 14, 1987; January 22, March 28, and May 18, 1988; November 20, 1991; and November 30, 1992. In addition, the licensee shall conduct its activities in accordance with the provisions in the following:

Submittal Date	Description
May 23, 1988	Enclosed errata sheet, replacement pages, and engineering design report dated April 27, 1988.
May 11, 1992	Cover letter submitting Supplement No. 2 to the Evaporation Pond Engineering Design Report addressing synthetic liners.
June 7, 1993	Cover letter and enclosed waste water irrigation proposal.

Notwithstanding the above, the following conditions shall override any conflicting statements contained in the licensee's application and supplements.

[Applicable Amendments: 1, 2, 3, 4, 6, 10, 11, 15, 17, 20, 21]

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GLOSSARY

acid generation. Water flowing through tailings or waste rocks containing pyrite.

AECB. Atomic Energy Control Board (Canada).

aquifer. Porous water-bearing formation (bed or stratum) of permeable rock, sand, or gravel capable of yielding significant quantities of water.

assessment. An analysis to predict the performance of an overall system and its impact. where the performance measure is radiological impact or some other global measure of impact on safety.

authorization. The granting of a **regulatory body** of written permission for an operator to perform specified activities. An **authorization** may be more informal or temporary than a **licence**.

baseline study. A study collecting all relevant information such as geological, biological data prior to an industrial project.

BATNEEC. Best Available Technology Not Entailing Excessive Cost. (South Africa)

biota. The animal and plant life of a region.

borehole; drillhole. A cylindrical excavation, made by a rotary drilling device. **Borehole**s are drilled during exploration for and delineation of uranium deposits as well as for evaluating the physical and chemical site characterization for siting waste sites.

CNS. Council for Nuclear Safety (South Africa).

CCNT. Conservation Commission of the Northern Territories (Australia).

codes of practice. A designation for legislation enacted by the Commonwealth of Australia.

commissioning. The process during which the facility's components and systems, having been constructed, are made operational and verified to be in accordance with design specifications and have met the required performance criteria. Commissioning may include both non-radioactive and radioactive testing.

contamination, radioactive. The presence of a radioactive substance or substances in or on a material or in the human body or other place where they are undesirable or could be harmful.

decommissioning. Actions taken at the end of the useful life of a **nuclear facility** in retiring it from service with adequate regard for the health and safety of workers and members of the public and protection of the environment. The ultimate goal of decommissioning is unrestricted release or use of the site. The time period to achieve this goal may range from a few to several hundred years. Subject to the legal and regulatory requirements of a Member State, a **nuclear facility** or its remaining parts may also be considered decommissioned of it is incorporated into a new or existing facility, or even if the site in which it is located is still under regulatory or institutional control. This definition does not apply to nuclear facilities used for mining and milling of radioactive materials (**closeout**) or for the **disposal** of radioactive waste (**closure**).

deposit. Mineral deposit or ore deposit is used to designate a natural occurrence of a useful mineral, or an ore, in sufficient extent and degree of concentration to invite exploitation.

development. To open up an orebody as by sinking shafts and driving drifts or developing wells (in in situ leach mines), as well as installing the requisite equipment.

disposal. The emplacement of waste in an approved, specified facility (e.g. near surface or geological repository) without the intention of retrieval. **Disposal** may also include the approved direct discharge of **effluents** (e.g. liquid and gaseous wastes) into the environment with subsequent **dispersion**.

DME. Department of Mines and Energy (Australia).

drill. Equivalent **bore**. To make a circular hole with a drill or cutting tool.

drillhole. Synonym for **borehole**.

DRIRE. Direction Regional de l'Industrie, de la Recherche et de l'Environnement".

effluent. A waste liquid, solid, or gas, in its natural state or partially or completely treated, that discharges into the environment.

EIA. Environmental Impact Assessment.

EIS. Environmental Impact Statement.

EMP. Environmental Management Programmes (South Africa).

EMPR. Environmental Management Programme Report (South Africa).

endangered species. A distinct class of animal or plant in danger of extinction, meaning their survival is in serious doubt.

environmental impact. The expected effects of the project upon the environment.

environmental impact statement. A statement of the expected effects of the project upon the environment, the conditions (if any) that should be observed to avoid or satisfactorily manage any potentially adverse effects of the project and the economic social and other consequences of carrying the project into effect.

exploration. The search for minerals or ore by geological and geophysical surveys, as well as by drilling or surface or underground headings, drifts or tunnels.

groundwater. That part of **subsurface water** that is in the saturated zone, including underground streams. The term excludes water of hydration. **Groundwater** can be brought to the surface by pumping.

heap leaching. In mining and milling, the process whereby leach liquid percolates through a pile of mined ore placed on an impervious base in such a way that the leachate can be collected for recovery of the metal values.

hydrology. The science dealing with water standing or flowing on or beneath the surface of the earth.

Impact Statement. A document describing the effect of a human activities on the environment.

ion exchange. Reversible exchange of ions contained in a crystal for different ions in solution without destruction of crystal structure of disturbance of electrical neutrality. The process is accomplished by diffusion and occurs typically in crystals possessing one or two dimensional channelways where ions are relatively weakly bonded. Also occurs in resins consisting of three dimensional hydrocarbon networks to which are attached many ionizable groups. Method used for recovering uranium from leaching solutions.

in situ leaching. (1) In mining and **milling**, the process whereby leach liquid percolates through or is injected into the **ore** body in such a way that the leachate can be collected for recovery of the metal values.

ISL. In Situ Leaching.

(2) The in-place mining of a mineral without removing over-burden or ore, by installing a well and mining directly from the natural deposit thereby exposed to the injection and recovery of a fluid that causes the leaching, dissolution, or extraction of the mineral.

law. A rule established by authority, society or custom.

leaching. The removal in solution of the more soluble minerals by percolating waters.

legislation. (a) the process of making laws.
(b) laws collectively.

licence. A formal, legally prescribed document issued to the applicant (i.e. **operating organization**) by the **regulatory body** to perform specified activities related to the siting, design, construction, **commissioning**, operation, **decommissioning** of a **nuclear facility, closure** of a **disposal** facility, **closeout** of a mining and mill tailings site, or institutional control. (See also **authorization**.)

licensee. The holder of a **licence** issued by the **regulatory body** to perform specific activities related to the siting, design, construction, **commissioning**, operation, **decommissioning** of a **nuclear facility, closure** of a **disposal** facility, **closeout** of a **mining** and mill **tailings** site, or institutional control. The applicant becomes the **licensee** after it receives a **licence** issued by the **regulatory body.**

limit. The value of a quantity which must not be exceeded.

Limits in radiation protection are as follows:

(1) Primary limits: Values of dose equivalent and/or effective dose equivalent applying to an individual. In the case of a member of the public the limit is taken to apply to the average dose in the critical group.

(2) Secondary limits: Values of the dose equivalent indices (deep and shallow), in the case of external exposure, or of annual limits on intake, in the case of internal exposure, which can be used to obtain an indirect assessment of compliance with primary limits.

(3) Derived limits: Values of quantities related to the primary or secondary limits by a defined model such that if the derived limits are not exceeded, it is most unlikely that the primary limits will be exceeded.

(4) Authorized limits: Limits of any quantity specified by the competent authority for a given radiation practice or source. These are generally lower than the primary, secondary or derived limits.

(5) Operational (radiation) limits: Limits of any quantity specified by the management for a given radiation practice or source. These are equal to or lower than the authorized limits.

milling of uranium. The processing of uranium from ore mined by conventional methods, such as underground or open pit methods, to separate the uranium from the undesired material in the ore.

mine water. Water generated by the mine.

mineral. A naturally occurring inorganic solid substance with a characteristic chemical composition.

mineral lease. See **mining lease**.

mineral right. The ownership of the minerals under a given surface, with the right to enter thereon, mine, and remove them. It may be separated from the surface ownership, but, if not so separated by distinct conveyance, the latter includes it.

mineralized. Mineral bearing, where a mineral is defined as a homogeneous naturally occurring inorganic phase.

mining. Process of obtaining useful minerals from the earth's crust, including both underground excavations and surface workings.

mining lease. A legal contract for the right to work a mine and extract the mineral or other valuable deposits from it under prescribed conditions of time, price, rental, or royalties. Also called **mineral lease**.

mitigation. The action of making a action less intense or severe.

mitigation measures. Measures that decrease the effect of an action on the environment.

monitoring. Maintain regular surveillance over a mining or milling site and its surroundings.

NEPA. National Environmental Policy Act (USA).

NOI. Notice of Intention (Australia).

NRC. Nuclear Regulatory Commission (USA).

open pit mine; opencast mine; opencut mine; strip mine. (1) A mine working or excavation open to the surface.

(2) A form of operation designed to extract minerals that lie near the surface. Waste, or overburden, is first removed, and the mineral is broken and loaded .

ore. A **mineral** or **rock** containing an element and/or compound in a quantity and of a quality so as to make **mining** and extraction of the element and/or compound economically or otherwise viable.

ore storage. An area or a building where the ore is stored before being processed through the mill.

overburden. Any loose sands and gravels that lie over bedrock.

panel. A group of people forming a team and appointed to revised a project.

PER. Preliminary Environmental Report (Australia).

permit. A document giving permission to act in a specified way.

piezometer. An instrument for measuring pressure head.

Prefect. Civil servant nominated by the Interior Ministry to direct all operation of this ministry at the level of a geographical Department (France).

preventive measures. Measures taken before an action happens.

processing radioactive ore. See **milling of uranium**.

production. That which is produced or made; any tangible result of industrial or other labor. The yield or output of a mine, metallurgical plant, or quarry.

prospect. To search for minerals or oil by looking for surface indications, by drilling boreholes, or both.

public hearings. The action by which the public has an opportunity to state its view regarding a project.

quality control. Action which provides means to control and measure the characteristics of an item, process, facility or person in accordance with **quality assurance** requirements.

radiation. Equivalent to **ionizing radiation**.

radiation dose. A term denoting the quantity of radiation energy absorbed by a medium. Sometimes shortened to dose.

radiation protection or radiological protection. Measures associated with limitation of the harmful effects of **ionizing radiation** on people, such as limitation of external **exposure** to such radiation, limitation of incorporation of **radionuclides** as well as the prophylactic limitation of injury resulting from either of these.

radioactivity. Property of certain nuclides to undergo spontaneous disintegration in which energy is liberated, generally resulting in the formation of new nuclides. The process is accompanied by the emission of one or more types of radiation, such as alpha particles, beta particles and gamma rays.

radionuclide. A nucleus (of an atom) that possesses properties of spontaneous disintegration (**radioactivity**). Nuclei are distinguished by their mass and atomic number.

radon. Chemically inert radioactive gaseous element formed from the decay of radium or **thorium** (which is then called **thoron**). A potential health hazard.

reclamation. Process of restoring surface environment to acceptable pre-existing conditions. Includes surface contouring, equipment removal, well plugging, revegetation, etc.

records. A set of documents, including instrument charts, certificates, log books, computer printouts and magnetic tapes kept at each **nuclear facility** and organized in such a way that they provide a complete and objective past and present representation of facility operations and activities including all phases from design through **closure** and **decommissioning** (if the facility has been decommissioned). Records are an essential part of **quality assurance**.

regulatory body, Regulatory Authority. An authority or a system of authorities designated by the government of a country or state as having legal authority for conducting the licensing process, for issuing **licences** and thereby for regulating the siting, design, construction, **commissioning**, operation, **closure**, **closeout**, **decommissioning** and, if required, subsequent institutional control of the **nuclear facilities** (e.g. near surface repository) or specific aspects thereof. This authority could be a body (existing or to be established) in the field of nuclear related health and safety, mining safety or environmental protection vested and empowered with such legal authority.

residues. All solids and associated liquids resulting from ore mining and milling to recover uranium and other minerals.

RFEP. Registered Facilities for Environmental Protection (France).

risk. The following alternative definitions may be relevant in the field of radioactive waste management:

- In general, risk is the probability or likelihood of a specified event occurring within a specified period or in specified conditions.
- In the **safety assessment** of radioactive waste repositories, risk may be used as a measure of safety. In this context it is defined as the product of the probability that an individual is exposed to a particular radiation **dose** and the probability of a health effect arising from that dose.

rock. In geology, any mass of **mineral** matter, whether consolidated or not, which forms part of the Earth's crust. Rocks may consist of only one **mineral** species, in which case they are called monomineralic, but they usually consist of several **mineral** species.

silt. Very fine sediment.

slimes, mill tailings. That fraction of a ground **ore** or **tailings** slurry consisting of very fine particles, usually less than 30-40 μm and typically with much material below 10 μm particle size. The solid particles will settle only slowly in an aqueous system (in a gravitational force field) and the removal of interstitial water and development of shear strength within the settled solids can be achieved only with difficulty.

solvent extraction. A method of separation in which a generally aqueous solution is mixed with an immiscible solvent to transfer one or more components into the solvent. Method used to recover uranium from leach solutions.

source material. Uranium or thorium ores containing 0.05 percent uranium or thorium regulated under the Atomic Energy Act. In general, this includes all materials containing radioactive isotopes in concentrations greater than natural and the by-product (tailings) from the formation of these concentrated materials (US usage).

sludge. Mud or cuttings made by a diamond drill.

stockpile. A supply of material stored for future use.

subsurface water. All water in both saturated and unsaturated zones beneath the land surface.

surface water. Water which fails to penetrate into the soil and flows along the surface of the ground, eventually entering a lake, a river or the sea.

tailings. (a) The remaining portion of a metal-bearing ore consisting of finely ground rock and process liquid after some or all of the metal, such as uranium, has been extracted.

(b) Heap leach residues, which result from treatment of **ore** by **heap leaching**.

tailings disposal. An area prepared for disposing of tailings.

tailings impoundment. A structure in which the **tailings** and tailings solution are deposited, including all its elements such as embankment walls, liners and cover layers.

tailings pile. A **deposit** of **tailings** material.

tailings seepage. *Seepage of liquid from a* ***tailings impoundment***.

transportation. Operations and conditions associated with and involved in the movement of radioactive material by any mode on land, water or in the air. The terms transport and shipping are also used.

underground. Situated, done or operating beneath the surface of the ground; therefore, tunneled.

uranium. A heavy, naturally radioactive, metallic element (atomic number 92). Its two principally occurring isotopes are uranium-235 and uranium-238. Uranium-235 is indispensable to the nuclear industry because it is the only isotope existing in nature to any appreciable extent that is fissionable by thermal neutrons. Uranium-238 is also important because it absorbs neutrons to produce a radioactive isotope that subsequently decays to the isotope plutonium-239, which also is fissionable by thermal neutrons.

VEC. Valued Ecosystem Component.

ventilation. The provision of an adequate flow of fresh air at all points within an underground mine.

waste, radioactive. For legal and regulatory purposes, radioactive waste may be defined as material that contains or is contaminated with radionuclides at concentrations or activities greater than clearance levels as established by the regulatory body, and for which no use is foreseen. (It should be recognized that this definition is purely for regulatory purposes, and that material with activity concentrations equal to or less than clearance levels is radioactive from a physical viewpoint — although the associated radiological hazards are negligible.)

waste management, radioactive. All activities, administrative and operational, that are involved in the handling, pretreatment, treatment, conditioning, transportation, storage and disposal of waste from a nuclear facility.

waste rock. Rock generated by mining activities which does not have a sufficient uranium or thorium content to be useful as **ore**.

waste rock pile. Rock coming from the mine that do not have an economic value.

water table. (a) The upper surface of the **groundwater**.
(b) The upper surface of a zone of **groundwater** saturation.

well. see borehole, drillhole.

yellow cake. (a) Sludge of uranium oxide concentrate formed during the final step of the milling process.

(b) Applied to certain uranium concentrates produced by mills. It is the final precipitate formed in the milling process. Usually considered to be ammonium diuranate, $(NH_4)_2U_2O_7$, or sodium diuranate, $Na_2U_2O_7$, but the composition is variable,and depends on the precipitating conditions.

(c) A common form of triuranium octoxide, U_3O_8, is yellow cake, which is the powder obtained by evaporating an ammonia solution of the oxide.

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