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**Rockwell Hanford Operations
Energy Systems Group
Richland, WA 99352**

**PROPOSED FORMAT AND CONTENT OF ENVIRONMENTAL
REPORTS FOR DEEP GEOLOGIC TERMINAL REPOSITORIES
FOR RADIOACTIVE MATERIAL**

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D. J. Carrell
G. L. Jones

Safety and Environmental
Engineering Analysis Department

October 13, 1978

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Program Office Representative
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Basalt Waste Isolation Program

Oct 12, 1978

Date

Rockwell International

**Rockwell Hanford Operations
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PREFACE

At present, Federal regulations and requirements for the licensing or approval of a terminal repository for radioactive waste do not exist. It is anticipated that in the future, Part 60 of Title 10 of the Code of Federal Regulations (10 CFR 60) will be developed and will contain requirements for a terminal repository comparable to those of 10 CFR 50 for nuclear power plants.

Prior to the construction of a terminal repository, the U.S. Department of Energy (DOE) will be required to submit an Environmental Report (ER) to the U.S. Nuclear Regulatory Commission (NRC). As with Environmental Reports for other nuclear facilities, this report must detail the environmental characteristics of the area in which the proposed repository is situated, and describe the potential for environmental interactions between the repository and surrounding area. Since the NRC has not yet issued a format guide for the preparation of such a report, Rockwell Hanford Operations has proceeded with the development of an annotated outline which will serve as the basis for the environmental evaluation activities until replaced by an appropriate NRC-issued regulatory guide.

The NRC's licensing procedures for nuclear power plants, and other production and utilization facilities associated with the nuclear fuel cycle, generally require that an Environmental Report be submitted to NRC by the applicant for a construction permit.

Utilized in the compilation of this format were the 1978 draft, "Plan For The Preparation of Environmental Reports For Radioactive Waste Repositories In Rock Salt Formations," prepared jointly by NUS Corporation and the Office of Nuclear Waste Isolation personnel, "Proposed Format and Content of License Applications for Deep Geologic Terminal Repositories for Radioactive Material," RHO-BWI-CD-16, September 1978, by Rockwell Hanford Operations, and draft, "Proposed Environmental Report Outline for the Waste Isolation Pilot Plant," April 1978, by Bechtel National, Inc. (BNI), NUS Corporation and Office of Waste Isolation personnel.

The U.S. NRC Regulatory Guide utilized in this compilation was Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Stations, Revision 2," July 1976. Additional information and typical guidance for preparers of the ER are contained in the "Standard Review Plan for Regulatory Guide 4.2."

It should be noted that the following Regulatory Guides were also evaluated: 3.15 "Standard Format and Content of License Applications for Storage Only of Unirradiated Reactor Fuel and Associated Radioactive Material," October 1973; and 3.24 "Guidance on the License Application, Siting, Design, and Plant Protection for an Independent Spent Fuel Storage Installation," December 1974. Although these guides were not included in the format and content development, because their structure and content were not developed to the corresponding level of detail, they provided additional insight into the environmental concerns of NRC.

At the present stage of waste repository development, a rigid Environmental Report format outline should not be expected; changes should be anticipated and allowance made for incorporation of these changes into the Environmental Report development plans.

SUMMARY

The applicant should summarize the major environmental effects that are expected to occur during the construction, operation, and terminal isolation phases of the radioactive material repository. Compare these environmental effects to the possible effects of continued use of interim storage facilities. Unless unforeseen environmental effects become apparent, the summary should be a positive statement indicating that the short-term environmental effects are outweighed by the long-term benefits of the repository.

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APPENDICES

GLOSSARY

ABBREVIATIONS AND ACRONYMS

BIBLIOGRAPHY

CALCULATIONS

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1.0 NATURE AND PURPOSE OF A REPOSITORY FOR RADIOACTIVE MATERIAL

This chapter will provide basic introductory information concerning a radioactive material repository. This information should include the purpose of the repository, the need for the repository, and the general plans and schedules necessary to construct the repository. The sections of this chapter should provide an overview of sufficient depth and detail to understand the basic concepts relative to storing nuclear material in geologic media. This overview will allow the reader to better understand the relationship between the repository and the specific environmental factors to be discussed in subsequent chapters.

1.1 STATEMENT OF THE PROPOSAL

Briefly describe the radioactive material repository for which a license is requested. Include the purpose of the repository, capacity, and the various phases of operation (i.e. the operational phase and the terminal isolation phase).

1.2 NEED FOR A RADIOACTIVE MATERIAL REPOSITORY

Briefly discuss the need for a geologic repository to terminally isolate radioactive materials from the biosphere. Emphasis should be placed on the fact that nuclear materials already exist and are currently being stored in interim facilities. Discuss the fact that the design life of various interim storage facilities is relatively short when compared to the time frames necessary for decay of radionuclides to environmentally acceptable levels.

1.2.1 Radioactive Material Types, Quantities, and Production Rates

Discuss the various types of radioactive material expected to be emplaced in the repository. Types of defense wastes, commercial wastes, etc., should be described in reasonable detail.

1.2.2 Present Disposition

Discuss the present methods used to store radioactive material and indicate the expected storage times before releases of radioactive material to the environment might occur.

1.3 TECHNOLOGY OF NUCLEAR MATERIAL STORAGE IN GEOLOGIC MEDIA

This section will present a historical outline of the handling of high-level radioactive material and the development of the technology for terminal storage. Experiences with defense wastes, commercial radioactive materials, and the Oklo phenomena should be described.

1.4 SUMMARY OF REPOSITORY PLANS

For each of the following subsections describe the plans and procedures to be used during the following repository stages. Where applicable, include rationale for specific plans relative to mitigating environmental effects of each stage.

1.4.1 Site Preparation

1.4.2 Construction

1.4.3 Transportation

1.4.3.1 Offsite Interfaces

1.4.3.2 Onsite

1.4.4 Operational Phase

1.4.5 Decontamination and Decommissioning

1.4.6 Terminal Isolation Phase

1.5 PROJECT SCHEDULE

Discuss the project schedule for construction of the geologic repository. Sufficient detail should be provided to show the constraints and dependencies imposed by licensing as well as the construction process.

1.6 NUCLEAR POWER AND THE FUEL CYCLE IN THE UNITED STATES

This section should emphasize the need for nuclear material storage facilities to serve the U.S. nuclear power industry. It should use the most up-to-date information, official projections, and plans. The past and projected U.S. electric power production should be first presented. The past and projected fraction of that power produced from nuclear fuel consumption should then be presented. The projected quantities and forms of wastes (e.g., spent fuel or reprocessing wastes) should be presented. Finally the capacity of the proposed repository should be compared with the amounts of existing and projected radioactive materials (e.g., to show how long the proposed facilities would serve the nuclear industry). Other ongoing plans for construction of terminal storage facilities should be presented along with indications of their capacity, scheduled availability and committed uses.

1.7 INTERNATIONAL NUCLEAR MATERIAL

In the event that international nuclear materials are proposed to be stored in the facility, a clear, quantitative accounting of U.S. responsibilities, in accordance with national policy, should be developed. It may take the form of a presentation of the international nuclear activities, both past and projected, which are based on the use of U.S.-supplied nuclear materials. This may be followed by a presentation of the existing and projected quantities and categories of radioactive materials. Finally, the present and projected disposition of these materials, especially to show quantities destined to return to the United States, should be presented. Any special and important problems

that may accrue from differences in the forms of radioactive material (e.g., due to differences in regulatory requirements among nations) and may affect environmental impact should be addressed. The capacity of the proposed repository should be compared with the quantities of the international nuclear materials anticipated to be stored there.

1.8 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

2.0 THE SITE AND ENVIRONMENTAL INTERFACES

This chapter must provide information about the repository location, and a description of the geographical, demographic, institutional, meteorological, hydrological, seismological, and geological characteristics of the site and its surroundings. The objective here is to indicate what site characteristics and institutional authorities influence facility design and operation selection. The site's environmental characteristics must be evaluated, with assumptions identified that need to be applied in making an objective environmental appraisal.

From the site description viewpoint, it may be useful to consider the repository facility as consisting of two parts, an operational phase emplacement facility and a terminal phase storage medium. Although parts of the repository belong to both parts of the system, by and large the former has a working life of a few decades and can be engineered to ameliorate existing conditions whereas the latter has a working life of hundreds of thousands of years and cannot readily be modified or improved during its required lifetime. Because of this unique situation, the confinement capabilities of the underground facilities are essentially those of the site. It follows that Chapter 2.0 is of critical importance and that the site description process must be one which provides all data required for both the operational phase and terminal phase stability evaluations. Chapter 2.0 then becomes, in a sense, a defense of the site selection process, and the descriptions of site characteristics set down in Chapter 2.0 must demonstrate that the repository medium should remain stable and unbreached throughout the life of the facility, or, if breached that there would be little or no adverse effects. To the extent possible, the information should reflect observations and measurements made over a period of years.

2.1 GEOGRAPHY

Provide information concerning the site and its geography.

2.1.1 Location and Description

Clearly indicate the location of the facility site so it is unambiguously situated in relation to features developed later in this chapter. Describe the site location by specifying the latitude and longitude of the repository to the nearest second, and the Universal Transverse Mercator coordinates* to the nearest 100 meters (m). Identify the state and county in which the site is located, as well the location in relation to prominent natural and man-made features, such as rivers, lakes, and reservoirs. To facilitate presenting this information, provide maps and aerial photographs. The general location map must include an area within at least an 80-kilometer (km) radius of the facility. Provide additional maps to present details near the facility and site plots to establish the orientation of buildings, rooms, tunnels, shafts, streams, ponds, transmission lines, and neighboring structures. Details in this section may be referred to in subsequent chapters to minimize repetition.

As indicated above, include a suitably scaled site map that defines its boundaries and the distance from significant facility features to those boundaries.

Describe the topography of the site and vicinity, using contour maps that indicate surface drainage patterns and the potential impact of surface winds.

Describe vegetative cover and surface soil characteristics in sufficient detail to indicate both potential erosion and fire hazards, and to permit evaluation of the present aesthetic, scientific, and economic value of the site. Animal habitat and species composition should be similarly characterized.

Identify traffic and transportation routes, and onsite electric power transmission lines.

2.1.2 Control Zones

Identify the boundaries for any applicant activity conducted within the area controlled by the applicant, but not related to the repository operation.

*As found on U. S. Geological survey topographical maps.

Clearly delineate the control of surface and subsurface access to surrounding areas, and relate these boundaries to those of the site.

Identify the restricted area, as defined in 10 CFR 20, Paragraph 20.3(a)(14) to show the boundary line that will be used to establish effluent release limits. This boundary line, which may or may not be the same as the repository property lines or the exclusion area boundary line, demarcates the area whose access will be actively controlled to protect individuals from exposure to radiation and radioactive materials. The applicant must control access to comply with the radiation protection requirements of 10 CFR 20. The site map discussed in section 2.1.1 may be used to identify this area, or a separate map of the site may be used. Locate the boundary line with respect to nearby rivers and lakes, and clearly indicate distances from the repository effluent release points to the boundary line.

2.1.3 Rights of Way

Using suitable, scaled map(s), describe the rights of way established for the transportation of radioactive material to and from the repository.

2.1.4 Land Ownership and Lease Holds

Indicate the applicant's legal rights with respect to the properties described (e.g., ownership, lease, easements, mineral rights).

2.2 POPULATION CHARACTERISTICS

2.2.1 Background Information

Set forth population information based on the most recent and postulated future census data to show the population distributions as a function of distance and direction.

2.2.2 Population Distribution

Population data presented should be based on the most recent census data. The following information should be presented on population distribution.

2.2.2.1 Population Within 16 Kilometers

On a map of suitable scale that identifies places of significant population grouping, such as cities and towns within a 16-km radius, concentric circles should be drawn, with the repository at the center point, at distances of 1.6, 3.2, 4.8, 8, and 16 km. The circles should be divided into $22\frac{1}{2}$ -degree sectors with each sector centered on one of the 16 compass points (with reference to true north, e.g., north-northeast, northeast, etc.). A table appropriately keyed to the map should provide the current residential population within each area of the map formed by the concentric circles and radial lines. The same table or separate tables should provide the projected population within each area for (1) the expected first year of repository operation and (2) by census decade through the projected repository life. The tables should provide population totals for each sector, annular ring, and a total for the 0 to 16 km enclosed population. The basis for population projections should be described. Furnish the age distribution of the projected population (e.g., 0 to 12 years, 12 to 18 years, 18 years) for the year corresponding to the midpoint of the repository operating life. The distribution by age of the U.S. population may be used provided there is no knowledge the site has a significantly different distribution. Table 2-1 provides guidance concerning the use of the U.S. age population distribution.

2.2.2.2 Population Between 16 and 80 Kilometers

A map of suitable scale and appropriately keyed tables should be used in the same manner as described above to describe the population and its distribution at 16-km intervals between the 16- and 80-km radii from the repository. Furnish the age distribution of the projected population (e.g., 0 to 12 years, 12 to 18 years, 18 years) for the year corresponding to the midpoint of the repository operating life. The distribution by age of the U.S. population may be used provided there is no knowledge the site has a significantly different distribution. Table 2-1 provides guidance concerning the use of the U.S. age population distribution.

TABLE 2-1

USE OF U.S. AGE GROUP POPULATION
DISTRIBUTION DATA

The distribution by age of the U. S. population may be used provided there is no knowledge that the area within a radius of 80 km of the site has a significantly different distribution. The test of significance is to be made by a determination of whether the age distribution in the county in which the proposed repository is to be located varied more than 10 percent from the U. S. population in the 1970 decennial census. If this occurred for any of the three age groups, a refinement of the U. S. age group distribution should be made as described below.

The Bureau of Economic Analysis (BEA), U. S. Department of Commerce, has unpublished data on age distribution for 157 BEA regions covering the U. S. These data were compiled for the Office of Business Economics, Department of Commerce and Economic Research Service (OBERS), Department of Agriculture projections. The age groups are 0 to 14 years, 15 to 64 years, and over 64 years. These data may be obtained without charge by request to the U. S. Department of Commerce, Bureau of Economic Analysis, Washington, D.C.

In employing the OBERS regional forecasts, the ratio-trend method may be used for the disparate class intervals of the age groups. First, select the BEA region containing the county in which the proposed repository is to be located. Obtain the age distribution of the region from the above reference. The 0- to 11-year age group population for the BEA area at the midyear of the life of the proposed repository can be considered to be 80% of the 0- to 14-year age group since the former was 77% of the latter as of July 1, 1974, and is forecasted at 79% by July 1, 2000. The 12- to 18-year age group requires a different approach. The procedure that should be used makes use of existing forecasts to estimate this age group for the area surrounding the site. It assumes that dependent age groups, i.e., 0 to 18 years, are in about the same proportion for various areas since they generally migrate with their parents. Moreover, this procedure takes advantage of the tendency of birth rate changes across regions to follow similar patterns of changes with different lead-lag relations. The forecasts to be used are for the year of the midpoint of the repository operating life. Specific year figures can be obtained by interpolation or extrapolation from the years that are available. The percent of the BEA region population forecasted to be in the 12- to 18-year age group should be found from the following equation:

$$A = B \times \frac{C}{D}$$

where

A = % of BEA region population forecasted to be in the 12- to 18-year

TABLE 2-1 CONT'D

age group at the midpoint year of repository operation,

B = % of U.S. population forecasted to be in the 12- to 18-year age group at this midpoint year of repository operation,

C = % of BEA region population forecasted to be in 0- to 14-year age group at the midpoint year of repository operation, and

D = % U.S. population forecasted to be in 0- to 14-year age group at the midpoint year of repository operation.

A is then used to estimate the number of persons in that age group for the area within 80 km of the proposed site by multiplying the percentage distribution calculated from the above equation by the total population projected for this local area. The population of the 19-years-and-over age group can be obtained by subtracting the sum of the 0 to 11-year and 12- to 18-year age groups from the projected total population of the local area.

2.2.2.3 Transient Population

Seasonal and daily variations in population and population distribution within 16 km of the proposed repository resulting from land uses such as recreational or industrial should be generally described and appropriately keyed to the areas and population numbers contained on the maps and tables of Sections 2.2.2.1 and 2.2.2.2. If the repository is located in an area where significant population variations due to transient land use are expected, additional tables of population distribution should be provided to indicate peak seasonal and daily population. The additional tables should cover projected as well as current populations. Wherever possible, applicants should state the expected residence times for the transient population.

2.3 USES OF ADJACENT LANDS AND WATERS

Describe land and water use, during the operational phase, within at least an 8-km radius of the site. Identify local populations in facilities, such as schools and institutions with respect to their locations and numbers. Present sufficient details of farming, dairy, industrial, commercial, residential, community facilities, and recreational activities to permit an estimation of potential radiation dose commitments resulting from facility effluents.

Identify the nature of activities conducted, if any, within the site boundaries other than those directly related to the operation of the facility. Explain the interrelation of these activities to the repository facilities.

2.4 GOVERNMENTAL AUTHORITIES

Describe local, regional, and state authorities that could influence or condition the implementation, operation, and terminal phase surveillance of the repository.

2.5 ECOLOGY

In this section, the applicant should describe the flora and fauna in the vicinity of the site, their habitats, and their distribution. Appropriate map(s) to augment the description should be used. This

initial inventory will reveal certain organisms which, because of their importance to the community, should be given specific attention. A species is "important" if a specific causal link can be identified between the repository and the species and if one or more of the following criteria applies: (a) the species is commercially or recreationally valuable, (b) the species is threatened or endangered, (c) the species affects the well-being of some important species within criteria (a) or (b), or (d) the species is critical to the structure and function of the ecological system or is a biological indicator of radionuclides in the environment.

The initial inventory should establish the identity of the majority of terrestrial and aquatic organisms on or near the site and their relative (qualitative) abundances. The applicant should identify the "important" species from this list and discuss in detail their quantitative abundances. The discussion should include species that migrate through the area or use it for breeding grounds. Special attention should be given to the relative importance of the repository area to the total regional area of the living resources (potential or exploited).

The applicant should provide data on the count and distribution of important domestic fauna, in particular cows and goats, that may be involved in the radiological exposure of man via the iodine-milk route. A map that shows the distribution of the principal plant communities should be provided.

The discussion of species-environment relationships should include descriptions of area usage (e.g., habitat, breeding, etc.) for important species; it should include life histories of important regional terrestrial and aquatic organisms, their normal seasonal population fluctuations, the density and distribution of their planktonic life stages, and their habitat requirements; and it should include identification of food chains and other interspecies relationships, particularly when these are contributory to predictions or evaluation of the impact of the repository on the regional biota.

Identify any definable preexisting environmental stresses from sources such as pollutants, as well as pertinent ecological conditions suggestive of such stresses. The status of ecological succession should be described. Discuss the histories of any infestations, epidemics, or catastrophes (caused by natural phenomena) that have had a significant impact on regional biota. The information requested above should be presented in the following subsections.

2.5.1 Terrestrial Ecology

2.5.2 Aquatic Ecology

The sources of information should be identified. As part of this identification, present a list of pertinent published material dealing with the ecology of the region. Locate and describe any ecological or biological studies of the site or its environs currently in progress.

2.6 METEOROLOGY

This section must provide a meteorological description of the site and its surrounding area. Include sufficient information to permit an independent evaluation of atmospheric diffusion characteristics of the local area. State the sources of information and data supplied. In addition, analyze the paleoclimatology to provide the basis for extrapolating future climatic trends.

2.6.1 Regional Meteorology

Describe the climate of the region, and point out characteristics attributable to the terrain. All information should be reported in sufficient detail to measure climatic impacts on the operational and terminal phases of the repository.

2.6.2 Local Meteorology

2.6.2.1 Onsite Meteorological Measurement Program

Describe the onsite meteorological measurement program being conducted to develop local data and the programs that will be used during operations to estimate offsite concentrations of monitored stack effluents. Set forth the joint-frequency distributions of wind speed,

wind direction, and atmospheric stability, based on meteorological measurement heights and data reporting periods. Identify collection methods, frequencies of collection, and problems associated with the sampling program.

2.6.2.2 Normal and Extreme Values of Meteorological Parameters

Provide monthly summaries of wind (direction and speed combined), temperature, atmospheric water vapor (absolute and relative), precipitation (rain and snow), fog, and atmospheric stability (if available), along with the daily high, low, and mean joint-temperatures and specific humidity throughout the year.

2.6.2.3 Topography

Describe the topographic characteristics of the site in detail, including a topographic map to a radius of 80 km from the facility and topographic cross sections in 16 compass point sectors radiating from the plant to at least a distance of 8 km. The map should indicate sufficient vertical differences to be used in meteorological analysis.

2.6.3 Short-Term (Accident) Diffusion Estimates

2.6.3.1 Basis

Conservatively estimate atmospheric dilution at the site boundary for appropriate time periods after an accident, based on onsite and local meteorological data. Include consideration of any influence the local topography may have.

2.6.3.2 Calculations

Describe the diffusion equations and the parameters used in the diffusion estimates.

2.6.4 Long-Term (Routine) Diffusion Estimates

2.6.4.1 Basis

Estimate atmospheric dilution realistically to a distance of 80 km, based on appropriate meteorological data.

2.6.4.2 Calculations

Describe the diffusion equations and parameters used in the diffusion estimates.

2.7 HYDROLOGY

The effects of repository construction and operation on adjacent surface and subsurface waters are of prime importance. The applicant should describe, in quantitative terms, the physical, chemical, biological, and hydrological characteristics, the typical seasonal ranges and averages, and the historical extremes for surface and subsurface water flow systems.

2.7.1 Surface Hydrology

Information should be provided only for those waters that may affect repository effluents and water supply or that may be reasonably assumed to be affected by the construction or operation of the repository. For those water flow systems that may receive radionuclides from the repository, the data should be supplied out to a radius of 80 km from the site.

Expected seasonal and other temporal variations of important parameters such as flow and currents should be described monthly; daily or shorter increments should be provided when they are important in determining the basis for evaluation of environmental effects.

The applicant should identify, to the extent possible, the source and nature of the background pollutants (e.g., chemical species and physical characteristics such as color and temperature), the range of concentrations involved, and the time variations in release. Information relating to water quality characteristics should include measurements made on or in close proximity to the site.

Repository construction and operation may affect the hydrologic characteristics in the site area. Information should be provided to establish the bases for estimates of the effects. For systems involving water impoundments, the flow rates (in and out), evaporation, drawdown, percolation, evapotranspiration, and net volumes should be provided. In

addition, provide elevation-area-capacity curves. Furnish sufficient site-specific data to justify the evaluation of the effects of construction and operation of the repository on established ground water tables and usage.

In order to develop a systematic evaluation of the interaction of proposed releases with the receiving water, and to permit establishment of distributional isopleths of temperature or chemical and radionuclide concentrations, as discussed in Chapter 5 of this format, detailed hydrologic descriptions of the site environment to a radius of 80 km are necessary. (Note that water use is discussed in Section 2.3).

For the surface water environment, site-specific hydrologic information should include descriptions of both tidal and nontidal flow patterns. For large lakes and coastal regions, the description of nontidal circulation should include frequency distributions of current speed direction and persistence.

The seasonal cycles of temperature and salinity structure should be provided. Additionally, information should be included that describes the bottom and shoreline configuration, sedimentation rates (suspended and bed load), sediment gradation analysis, and distribution (sorption) coefficients.

2.7.2 Subsurface Hydrology

For the subsurface water environment, the hydrologic information should include descriptions of the major aquifers in the area, subsurface water piezometric contour maps of pre-and postconstruction conditions, hydraulic gradients, permeabilities for representative geologic features, total and effective porosities, recharge and depletion predictions, bulk density estimates, storage coefficients, dispersion and distribution (sorption) coefficients, descriptions of pertinent geologic formations and soil types, including formation depth throughout the site and to the nearest downgradient well or water flow system (note that geology is discussed in Section 2.8), chemical properties, and time histories of ground water fluctuations. The applicant should provide data concerning any drawdown of ground water caused by withdrawals from neighboring major industrial and municipal wells that may result in the transport of material from the site to these or other wells.

Where features of a proposed repository such as foundations, excavations, artificial lakes, and canals create artificial conduits for flow of ground water between and among aquifers, the applicant should furnish sufficient site-specific detail to justify its evaluation of the effects of construction and operation of the repository on established ground water tables and usage. (Note that water use at the site is discussed in Section 2.3).

In addition to providing the information described above for the hydrologic environment in the immediate vicinity of the repository, information should also be provided for all points that could be affected by repository construction and operation within the 80 km radius where water is withdrawn or where there are significant changes in important parameters. All data for parameters should be adjusted to both present-day conditions and to those that may reasonably be expected to occur over the life of the repository. Chemical and biological parameters of the hydrologic environment should be described in a like manner.

The amount of information required for evaluation of radionuclide transport in water should be commensurate with the models used in support of the analysis presented in Section 5.1.1.3.2.

2.8 GEOLOGY

Provide the geologic characteristics of the area and site; indicate how these investigations were performed and the conclusions reached; and identify information sources. Supplement the written description with tabular and graphic presentations as appropriate.

2.8.1 Regional Geology

- o Describe the regional geomorphology, and discuss the relationship between the regional and the site geomorphology. Include a regional geomorphologic map showing the site location.
- o Describe the regional geology, including geologic and tectonic maps of the region surrounding the site.

- o Discuss the regional geologic setting. Indicate the geologic province and its relation to other geologic provinces. Include regional geologic maps indicating the site location, and showing both surface and bedrock geology.
- o Discuss the regional geological and structural history to evaluate the suitability of the region to accommodate a repository. Provide detailed regional gravity and magnetic maps, isopach maps of the principal geologic units, structure and fault maps, a map showing areas of mineral and fluid extraction, and stratigraphic sections, as well as supporting data such as remote sensing imagery, boring logs, etc.
- o Describe the lithologic, stratigraphic, and structural geologic conditions of the region surrounding the site, and relate these conditions to its geologic history. Provide geologic profiles showing the relationship of the regional and local geology to the site location.
- o Identify and describe tectonic structures underlying the region surrounding the site such as folds, faults, basins, and domes. Discuss the geologic history of the tectonic features. Include a regional tectonic map showing the site location. Discuss the regional tectonic structures of significance to the site. Analyze faults to determine their capacity for generating ground motions at the site and to determine the potential for surface faulting. Identify and describe areas of actual or potential surface or subsurface subsidence, uplift, or collapse resulting from: (a) natural features such as tectonic depressions, cavernous conditions or karst terrains, and potential landslides; (b) man's activities, such as withdrawal or addition of subsurface fluids, or mineral extraction; and (c) regional warping.
- o Discuss the regional ground water conditions by cross-reference to Section 2.7.2.
- o Describe the Pleistocene climate of the region, with discussion of the following elements: proximity to continental ice sheets; proximity to alpine glaciation; occurrence of, or proximity to such periglacial features as outwash plains, moraines, kettle holes, lake

deposits, and strand lines. Provide a map of the region showing features resulting from continental and/or alpine glaciation and associated Pleistocene erosional features.

- o Provide a detailed description of the chemistry, mineralogy, and fluids contained in rocks above, in, and below the repository. Compare these parameters with those of average sedimentary rocks to ensure that no unusual concentrations exist which may cause the repository to become a target for mineral exploration in the distant future.

2.8.2 Surface Geology

- o Describe the site geomorphology and the relationship between the regional and site geomorphology. Include a site topographic map that shows the locations of the principal facilities. Describe the configuration of the land forms and relate the history of geologic changes that have occurred. Evaluate areas significant to the site for actual or potential landsliding, surface or subsurface subsidence, uplift, or collapse resulting from natural features such as tectonic depressions and cavernous or karst terrains.
- o Describe the lithologic, stratigraphic, and structural geologic conditions of the site, and relate them to geologic history and regional geology. Describe the thickness, physical characteristics, origin (as appropriate), and degree of consolidation of each lithologic unit. Furnish summary logs of borings and excavations, such as trenches, used in the geologic evaluation.
- o Discuss the structural geology in the vicinity of the site in detail, with particular attention to structural units of significance to the site, such as fold, faults, synclines, anticlines, domes, and basins. Provide a large-scale site structural geology map showing bedrock surface contours and include the locations of the major facility structures. Relate these site structure features to regional tectonics and regional structural features.
- o Furnish a large-scale geologic map of the site area that shows surface hydrology and that indicates the locations of the proposed facility's major structures. Distinguish areas of bedrock outcrop identified by

direct observations from areas that are covered and that have been interpreted geologically by extrapolation. When the interpretation differs substantially from published geologic literature on the area, note the differences and document the new conclusions presented.

- o Discuss the geologic history of the site and relate it to regional geologic history. Include a local geologic stratigraphic column
- o Furnish a plot plan showing the locations of major repository structures, and the locations of all borings, trenches, and excavations; also include descriptions, logs and maps of the borings, trenches, and excavations, as necessary, to indicate the results.
- o Provide geologic profiles showing the relationship of the major foundations of the repository to subsurface materials, including ground water, and the significant engineering characteristics of subsurface materials.
- o Provide plan and profile drawings showing the extent of excavations and backfill planned at the site, as well as the compaction criteria for all engineered backfill.
- o From an engineering geology standpoint, evaluate local geologic features that affect proposed repository structures. Geologic conditions underlying all structures, dams, dikes, and pipelines should be described in detail.
- o From the lithologic, stratigraphic, and structural geologic studies, describe the physical evidence concerning the behavior during prior earthquakes of surficial geologic materials and substrata underlying the site. Identify and evaluate deformational zones, such as shears, joints, fractures, and folds, or combinations of these features in relation to proposed structural foundations. Describe and evaluate zones of alteration or irregular weathering profiles, and zones of structural weakness composed of crushed or disturbed materials. Describe unrelieved residual stresses in bedrock. Describe all rocks or soils that might be unstable because of their mineralogy, lack of consolidation, water content, or potentially undesirable response to seismic or other events. (Seismic response characteristics to be considered include liquefaction, thixotropy, differential consolidation, cratering, and fissuring.) Evaluate the effects of

man's activities, such as withdrawal or addition of subsurface fluids, or mineral extraction at the site.

- o Define site ground water conditions and cross-reference them with Section 2.7.2.
- o Provide profiles and tables showing the results of any geophysical surveys (e.g., seismic refraction, seismic reflection, acoustic, and aeromagnetic) conducted to evaluate the stratigraphic structure and bedrock, and subsurface material characteristics of the site. Provide the results of compressional and shear wave velocity surveys, and of cross-hole and up hole velocity surveys if performed.
- o Furnish static and dynamic soil and rock properties of the site, including grain-size classification, Atterberg limits, water content, unit weight, shear strength, relative density, shear modulus, Poisson's ratio, bulk modulus, damping, consolidation characteristics, and strength under cyclic loading. Substantiate these properties with representative laboratory test records.
- o Detail the safety-related criteria, analysis techniques to be used, and safety factors for the materials underlying the foundations of major repository structures and for all embankments under dynamic shaking conditions combined with adverse hydrologic conditions.

2.8.3 Subsurface Geology

When appropriate, repeat and cross-reference information provided in Section 2.8.2 in this section. This section is primarily concerned with the characterization of the subsurface repository location until the site is decommissioned.

- o Discuss the historical stability of the geologic formation that will contain the material, as well as the formations above and below the disposal location. Determine whether the formations are currently undergoing deformation or movement; if so, indicate how this may affect operation until the facility is decommissioned. Provide a map that shows the relationship of the proposed repository location to the surrounding formations, with the major lithologic and structural units indicated.

- o Describe the lithologic, stratigraphic, and structural geologic conditions of the formation(s) where the radioactive material will be repositied. Describe the thickness, physical characteristics, and degree of consolidation of each lithologic unit. Furnish summary logs of borings used in the evaluation (refer to Section 2.8.2).
- o Discuss the structural geology in the vicinity of the site, in detail, with particular attention to significant structural units of the repository site, such as folds, faults, and synclines. Provide large-scale isopach maps of the formations involved with the structural features (e.g., faults) indicated (refer to Section 2.8.2).
- o Determine the presence or absence of pore fluids (liquids or gases) in formations affected by drilling, mining, and similar activities. Determine the composition of pore fluids, and the ability of pore fluids to migrate through the formation(s) involved and into the underground repository area. Determine the physical characteristics of the formations that may aid or retard fluid flow, such as the porosity and permeability of the lithologic units, presence or absence of fractures along which fluids may migrate, and formation pressures.
- o Discuss the effect of pore fluids on waste containment. Consider the ability of pore fluids to interact with the material containing the radioactive waste and to leach and transport the radioactive waste. In particular, (a) describe container-pore fluids and radioactive waste-pore fluid physical and chemical interactions; (b) determine the ways in which the radioactive waste containing materials may be affected by interacting with available pore fluids; (c) determine possible pathways away from the repository site that may become available to the radioactive waste once the integrity of the containment material has been breached; and (d) determine and evaluate procedures that may be used to prevent interaction of the radioactive waste containing materials and migration of radioactive waste from the repository site.
- o Determine the characteristics of the subsurface repository site, other than pore fluids, that may endanger personnel and/or interfere with proper radioactive material containment. Consider temperature,

overburden pressure, unrelieved stresses, and related factors.

Evaluate the effects that each factor will have on the construction of the site and on the safety of the personnel. Also consider the effects these factors will have on radioactive material containment, and determine and evaluate procedures necessary to mitigate these effects.

- o Furnish a plan of the locations of major features of the subsurface workings, including borings. Describe each with logs, maps, locations of borings, and other materials necessary to document the plan.
- o Provide plan and profile maps showing the extent of the excavation and backfill planned at the site, as well as compaction criteria for all engineered backfill.
- o Include an engineering geology description of local features that will affect subsurface facility areas and the repository site. Describe geologic conditions affecting underground facility areas in detail (refer to Section 2.8.2).
- o Describe physical evidence concerning the behavior of subsurface geologic materials and structures during earthquakes. Consider interactions of geologic materials and structures with subsurface facilities that may occur during earthquakes. Also consider the effect of an earthquake on radioactive materials already emplaced in the repository.
- o Identify and describe deformation zones such as shears, joints, fractures, folds, or combinations of these features in relation to subsurface facilities, backfilled areas, and repository site containing radioactive material.
- o Describe zones of alteration and zones of structural weakness.
- o Describe anticipated unrelieved stresses in formation(s) affected by any mining or drilling operations during construction. Describe all geologic materials affected by mining or drilling that might be unstable because of their mineralogy, lack of consolidation, water content, or potentially undesirable response to seismic or other

- events (e.g., consider liquefaction, thixotrophy, differential considerations, or other characteristics that may adversely affect mining or drilling operations).
- o Define site subsurface fluid flow conditions, with cross reference to Section 2.8.2.
 - o Consider the effects of local seismic activity on subsurface fluid flow. Determine ways in which fluid flow may be altered by such activity.
 - o Provide profiles and tables showing the results of geophysical surveys (e.g., seismic refraction, seismic reflection, acoustic, and aeromagnetic) conducted to evaluate the stratigraphic structure and bedrock, and subsurface material characteristics of the site. Provide results of compressional and shear wave velocity surveys with cross-hole and up hole velocity surveys, when performed.
 - o Furnish static and dynamic soil and rock properties of the site, including grain-size classification, Atterberg limits, water content, unit weight, shear strength, relative density, shear modulus, Poisson's ratio, bulk modulus, damping, consolidation characteristics, and strength under cyclic loading. These properties should be substantiated with representative laboratory test records.
 - o Discuss the detailed safety-related criteria, analysis techniques to be used, and the factors of safety for the materials affected by all facility-related mining and drilling activities under dynamic conditions combined with adverse hydrologic conditions.

2.9 SEISMOLOGY

Present the basic seismic information for the region and the site. Refer to information obtained from published reports, maps, private communications, or other sources. Adequately document information from surveys, geophysical investigations, borings, trenches, or other investigations by descriptions of techniques, graphic logs, photographs, laboratory results, identification of principal investigators, and other data.

2.9.1 Earthquake History

List all historically reported earthquakes that affected or that could be reasonably expected to have affected the site. Include the date of occurrence and the following measured or estimated data: highest intensity, and a plot of the epicenter or region of highest intensity. For earthquakes of at least 0.1 g, estimate the acceleration of intensity and duration of ground shaking at the locations of the foundations of the proposed surface facility or at the subsurface storage locations. Because earthquakes have been reported in terms of various parameters, such as magnitude, intensity at a given location, and effect on ground, structures, and people at a specific location, some of these data may have to be estimated by empirical relationships. When appropriate, consider the comparative characteristics of the material underlying the epicentral location or region of highest intensity and of the material at or near the site in regard to its ability to transmit earthquake vibratory motion.

2.9.2 Correlation of Epicenters With Geologic Structures

When possible, correlate epicenters of regions of highest intensity of historically reported earthquakes with tectonic structures, any parts of which are within 320 km of the site. Identify epicenters of regions of highest intensity (which cannot be reasonably correlated with tectonic structures) with respect to tectonic provinces*, any parts of which are located within 320 km of the site.

2.10 REGIONAL HISTORIC, ARCHEOLOGICAL, ARCHITECTURAL, SCENIC, CULTURAL, AND NATURAL FEATURES

Areas valued for their historic, archeological, architectural, scenic, cultural, or natural features may be affected. The environmental report should include a brief discussion of the historic, scenic,

*A tectonic province is defined as a region whose geologic structural features are relatively consistent. The boundaries of such a province are determined by regional analysis of the geologic and tectonic environments, and by the seismic history of the area.

archeological, architectural, cultural, and natural features, if any, of the repository site and nearby areas with specific attention to the sites and areas listed in the National Registry of Natural Landmarks and properties included in or eligible for inclusion in the National Register of Historic Places.

The National Registry of National Landmarks appears in 37 FR 1496. The National Register of Historic Places is published annually in the Federal Register; additions are published in the Federal Register on the first Tuesday of each month. General guidance on the treatment of historic, archeological, architectural, and cultural features can be obtained from the National Park Service publication, "Preparation of Environmental Statements; Guidelines for Discussion of Cultural (Historic, Archeological, Architectural) Resources," August 1973.

The environmental report should identify those properties included in or eligible for inclusion in the National Register of Historic Places which may be affected by the construction or operation of a repository or its associated facilities. Also, the applicant should discuss its consultation with the appropriate State Liaison Officer for Historic Preservation concerning the identification of properties included in or eligible for inclusion in the National Register of Historic Places. The environmental report should contain evidence of contact with the Historic Preservation Officer for the state involved, including a copy of his comments concerning the effect of the undertaking on historic, archeological, and cultural resources. Procedures for the protection of historic and cultural properties (36 CFR Part 800) were published in 39 FR 3366 (January 25, 1974).

The environmental report should also indicate whether or not the site has any archeological significance and how this conclusion was reached. Where necessary, professional quality assessments should be undertaken by archeologists. If such significance or value is present, the applicant's plans to ensure its preservation or plans filed in a public agency for this purpose should be described. The environmental report should contain evidence of any steps taken to recover historical and

archeological data affected by repository construction in accordance with the Historic and Archeological Preservation Act of 1974 (PL 93-291).

In addition, the applicant should provide an assessment of the visual effects of the repository on nearby valued cultural, scenic, historic, park, and recreation areas. The assessment should include drawings or modified photographs indicating the repository facilities and their surroundings, if visible from these nearby important vantage points, and estimates of the number of people affected.

2.11 NOISE

The present environmental sound levels in the site vicinity should be described in a summary manner, referring to the locational survey report which should be appended to this report for more detailed information.

The principal sources of noise, both man-made and natural, in the site vicinity should be identified. The daytime and nighttime L_{10} , L_{50} , L_{90} , and L_{eq} , and LA -weighted sound levels and octave band sound levels in the site vicinity should be summarized in tabular form for both the summer and winter seasons. Background A -weighted sound-level isopleths should be presented on site area maps for the summer and winter daytime and nighttime periods. Variations in the background sound levels due to the time of day or week, or seasonal effects should be described. The background sound levels should be compared with applicable noise regulations and impact criteria, including those set forth by the State, the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development.

2.12 RADIOLOGICAL BACKGROUND

Background radiation levels expected from the surrounding area (natural and man-caused) near the repository should be reported. Distances associated with these expected levels should be stated. Federal and state background radiation limits should be referenced, where applicable.

2.13 AIR QUALITY AND VISUAL QUALITY

Appropriate air quality and visual quality standards enforced by Federal, state, and county authorities should be stated. Indicate the

present status of air quality and visual quality parameters near the repository site.

2.14 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

3.0 THE FACILITY AND ITS OPERATION

This chapter will describe the proposed facility and all of the activities required for its construction, operation, postoperation surveillance, and decommissioning. The descriptions should provide quantitative characterizations of all facility inputs and outputs (e.g., labor and materials used, amounts of radioactive wastes received, amounts of waste rock stored on site and transported to offsite disposal, quantities and concentration of emissions and effluents).

3.1 GENERAL DESCRIPTION

Provide a general description in each of the following subsections discussing the facility and its operation.

3.1.1 Surface Facility

3.1.1.1 Location of Surface Facility

On an appropriately scaled map or drawing, locate the buildings and other installed surface features, as well as openings to the underground facilities of the repository. Also show roadways, railroad lines, parking areas, and utility and water service locations, with north-point direction indicated.

3.1.1.2 Perimeter Fences and Guardshacks

The location of access control fences, the "control area," and the "inner controlled area" should be presented on a map of the after-site-development topography at an appropriate scale. The "outer controlled area" should also be presented on a map of suitable scale.

3.1.1.3 Receipt and Packaging Facility

Provide a general description and layout (on appropriate scaled drawings) of the receipt and packaging facility. Cross-reference to Section 3.1.1.5 as appropriate.

3.1.1.4 Temporary Storage

Describe the portion(s) and feature(s) of the surface facilities used as temporary storage of the radioactive material destined for emplacement in the repository.

3.1.1.5 Onsite Transport

Provide a description of the repository site transportation system and its implementation, beginning with the point of assuming responsibility and ending at the repository surface receiving facility.

3.1.1.6 Ventilation System

Provide a description of features and limitations on performance of the surface ventilation-filtration system(s). Show that sufficient backup, excess capacity, repair and replacement capability, and structural integrity exist to ensure controlled, continuous airflow, in all credible circumstances, to minimize the release of radioactive particulates. Supplement the discussion with drawings that show the flow distribution, pressure differentials, air locks, flow quantity, velocity, filtering, and fan housing arrangements.

3.1.2 Shafts

3.1.2.1 Location and Depth of Shafts

The location of the access shafts should be shown on an appropriate topographic map and specified by latitude and longitude to the nearest second and by Universal Transverse Mercator Coordinates (zone number, northing and easting, as found on USGS topographic maps) to the nearest 100 meters (m). Using the same map and/or tables, provide the depth and diameter of each shaft in meters.

3.1.2.2 Man, Material, and Equipment Shaft(s)

3.1.2.3 Rock Transport Shaft(s)

3.1.2.4 Ventilation Shaft(s)

For each of the above subsections provide a description of the function(s) and feature(s) of each shaft. Also provide an estimate of the operational life of each shaft.

3.1.3 Subsurface Facility

For the subsurface facility, identify and discuss the general layout features that have been included to ensure confinement of radioactivity. (This should be a general discussion, with details presented in the applicable part of this section.) Discuss in the appropriate subsections below, ventilation, filters, piping, and other physical means such as seals and bulkheads, storage drifts, tunnels and drifts, and subsurface transporters. Identify the interfaces between the systems, and discuss the environmental aspects of the interfaces.

3.1.3.1 Tunnels and Drifts

3.1.3.2 Subsurface Transporters

3.1.3.3 Storage Drifts

3.1.3.4 Seals and Bulkheads

3.1.3.5 Filters, Ventilators, and Pumps

3.1.4 Remote Handling System

The principal function of the remote handling system is to transport waste capsules from cask separation to emplacement in the subsurface storage positions and return if necessary to the shipping facility. Specific functions are accomplished within the surface facilities, the waste transfer shaft, and the subsurface facility.

For each of the following subsections describe the systems associated with radioactive material receipt, handling, transfer, emplacement and retrievability. Present the provisions for: cooling; maintaining capsule in subcritical form; shielding; and monitoring for radioactive effluents.

Indicate the functions and pertinent design features of each operational system as they relate to facility or environmental safety.

3.1.4.1 Capsule Receipt and Preparation For Storage

3.1.4.2 Radioactive Material Transfer Between the Surface Facility and Subsurface Facility

3.1.4.3 Radioactive Material Transfer Between Shaft and Storage Position Within the Subsurface Facility

3.1.4.4 Radioactive Material Emplacement

3.1.4.5 Capsule Retrievability

3.1.5 Systems

Provide information about those systems that support the main operational and confinement features. Emphasize provisions made to cope with environmental releases. Define codes, specifications, and standards that will provide an environmental safety margin so that a single failure within a support system will not result in the release of radioactivity.

3.1.5.1 Water

Provide a description of the primary source of water supply, alternative sources, storage facilities, and distribution looping system. Itemize by service (potable, operations, and fire) the quantities of water used under normal conditions and the minimum requirements under emergency shutdown operations so that containment of radioactive releases are controlled.

3.1.5.2 Sanitary Sewage

Describe the sanitary sewage handling and disposal system (i.e., drains, sewers, etc.) to show that no radioactive material can be discharged in the sewage effluent, except perhaps trace amounts of laboratory wash water.

3.1.5.3 Electrical Power

3.1.5.3.1 Normal Service

Discuss the source and characteristics of the primary electrical system that provides normal power to the facility. If a secondary electrical system is to be provided (below ground), describe its source and interfaces with the primary system.

3.1.5.3.2 Emergency Service

Describe the design provisions for emergency power source(s) and the means for ensuring uninterruptible service to those facility functions requiring it.

3.1.5.4 Communications Systems

3.1.5.4.1 Normal Service

Discuss the external and internal communications systems, with emphasis on the components to be used under normal service conditions.

3.1.5.4.2 Emergency Service

Discuss the external and internal communications systems, with emphasis on the components to be used under emergency service conditions.

3.1.5.5 Fire Protection System

Provide a general description of the fire protection system, including preliminary drawings. Show the physical characteristics of each facility location and outline the fire prevention and fire suppression systems to be provided for all areas associated with environmental safety-related structures, systems, components.

Discuss the protection and suppression systems provided in the control rooms and other operating areas that contain environmental safety-related equipment.

Discuss smoke, heat, and flame control; combustible and explosive gas control, as applicable; and radioactive emissions control including the operating functions of the ventilating and exhaust systems during the period of fire extinguishing and control.

3.1.5.6 Compressed Air and Gases

Describe the system(s) for supplying the compressed air and gas needs of the facility, and the supply air required for protective masks and/or effluent monitors; list the components, their location, and their operating characteristics.

3.1.5.7 Steam Supply and Distribution

Describe the system(s) for supplying heating fuel(s) to the facility, including a discussion of fuel type and supply, storage vessels, boilers, and methods of distribution. As part of the discussion list the radioactive and nonradioactive effluents and their expected concentrations.

3.2 RADIOACTIVE MATERIAL HANDLED

3.2.1 Types and Criteria for Acceptance

In tabular form, indicate the types of radioactive material expected to be emplaced in the repository. This table should indicate the acceptance criteria (i.e., radiation limits, contamination limits and thermal limits based on required cooling times).

3.2.2 Arrival Rates

For each of the radioactive material types identified in Section 3.2.1, indicate arrival rates and the projected periods of delivery.

3.2.3 Quantities

Provide the expected and/or projected quantities per shipment and total quantities of radioactive material to be emplaced in the repository. The projected quantities should be provided on an annual basis as well as the total quantities expected.

3.2.4 Shipping Modes

Describe the intended shipping modes to transport the radioactive material to and from the repository.

3.3 OPERATIONAL SEQUENCE

For the radioactive material operations, sequentially describe the operational areas as listed below. For each operation, describe its function and specifications used to provide a sufficient margin of environmental safety under both the normal and accident conditions. Describe the operational systems that ensure that a single operational accident, or faulty radioactive material container, can or cask will not release significant radioactivity to the environment. Also discuss the features used to monitor radioactive effluents during the waste handling operational sequence.

3.3.1 Vehicular Arrival, Cleaning, Inspection

3.3.2 Offloading and Inspection

3.3.3 Lag Storage

3.3.4 Overpacking

3.3.5 Temporary Surface Storage

3.3.6 Transportation to Shaft(s)

3.3.7 Lowering

3.3.8 Transportation to Drifts

3.3.9 Emplacement

3.3.10 Capsule Retrieval

3.4 OPERATIONS PERSONNEL SUMMARY

Manpower requirements during construction and operation, approximately categorized by major facility and labor category should be presented.

3.5 Potential or Actual Sources of Effluents and Eventual Dispositions

3.5.1 Nonradioactive Effluents

Identify all nonradioactive effluent sources and their eventual disposition. Account for and quantify all combustion products, as well as all chemicals and effluents leaving the facility. This information is to be included to assist the staff in their determination that no radioactivity will be added to such sources, particularly effluents. Provide this information as it pertains to the following operational areas.

3.5.1.1 Surface Facility

3.5.1.2 Shafts

3.5.1.3 Subsurface Facility

3.5.1.4 Remote Handling System

3.5.1.5 Systems

3.5.2 Radioactive Effluents

Classify and quantify all anticipated radioactive effluents and their eventual disposition for the repository's operational phase, with respect to source, chemical and radiological composition. Provide this data as it pertains to the following operational areas.

3.5.2.1 Surface Facility

3.5.2.2 Shafts

3.5.2.3 Subsurface Facility

3.5.2.4 Remote Handling System

3.5.2.5 Systems

3.6 ONSITE GENERATED WASTE HANDLING SYSTEM(S)

Describe the operation of the waste handling system(s). Include appropriate action levels, action to be taken under normal and abnormal conditions, and methods for testability and accountability to ensure functional operation and control of radioactivity.

3.6.1 Nonradioactive Waste Systems

Describe the nonradioactive waste handling systems for the wastes listed below. Emphasize the operational and supporting systems for demonstrating that nonradioactive waste materials will be handled safely over the operational phase of the repository facility.

3.6.1.1 Solid Wastes

3.6.1.2 Liquid Wastes

3.6.1.3 Gaseous Wastes

3.6.2 Radioactive Waste Systems

This section should describe the liquid, gaseous, and solid radioactive waste (radwaste) treatment systems and the instrumentation used to monitor all effluent release points. The information should include the origin, treatment, and disposal of all liquid, gaseous, and solid radioactive wastes generated by the repository during normal operation including anticipated operational occurrences (e.g., equipment downtime, maintenance).

Since the radwaste systems are discussed and shown in detail in the applicant's Preliminary Safety Analysis Report (PSAR), the applicant may show the radwaste treatment systems by block diagrams. References to appropriate sections of the PSAR should be indicated wherever needed.

3.6.2.1 Solid Wastes

Describe the solid radwaste system and its capability to solidify liquid waste concentrates and to handle, store, and package for shipment the solid radioactive wastes generated as a result of normal operation including anticipated operational occurrences. Include any tanks designed to receive concentrated liquid wastes, sludges, or resins prior to processing in the solid radwaste system. Interconnections with liquid radwaste systems should be described. A description of the provisions for the compaction or baling of dry solid wastes should also be included. List estimated quantities from all sources. Estimated quantities should be given in terms of cubic feet of solid product (as processed and prepared for shipment), total curie content, and activity concentration in curies per package, or curies per cubic foot. Indicate if the solid radwaste system is shared with other units at the site.

Describe provisions for the storage of packaged solid wastes. Estimate the decay time provided in storage prior to shipment offsite.

Provide piping and instrumentation diagrams (P&IDs) and flow diagrams showing the origin, treatment, storage, and shipment provisions for all solid radwaste generated by the repository under consideration. Reference should be made to the appropriate sections of the PSAR. Show system and component capacities, and identify the normal mode of operation.

3.6.2.2 Liquid Wastes

Describe the liquid radwaste systems and their capabilities to control, collect, process, handle, store, and dispose of liquid radioactive wastes generated as the result of normal operation and anticipated operational occurrences. Provide P&IDs and flow diagrams for liquid radwaste systems. Reference may be made to the appropriate sections in the PSAR. Show tank capacities, system flow rates, and design capacities of components. Show all interconnections with other systems and all potential bypass paths. Identify the normal mode of operation. Provide estimated quantities and flow rates from all sources, expected decontamination factors, and holdup times. Estimated quantities should be given in terms of gallons, total curie content, and activity concentration in microcurie per milliliter ($\mu\text{Ci/ml}$).

Indicate which systems are used separately and which are shared with other units at the site, as appropriate. Provide a summary tabulation of all radionuclides that will be discharged with each effluent stream, and provide the expected annual average release rate in Curies per year (Ci/yr).

3.6.2.3 Gaseous Wastes

Describe the gaseous radwaste systems and their capabilities to control, collect, process, handle, store, and dispose of gaseous and particulate radioactive wastes generated as the result of normal operation and anticipated operational occurrences. Include building ventilation systems that exhaust potentially radioactive materials to the environment. Indicate systems that incorporate high-efficiency particulate air (HEPA) filters and/or charcoal adsorbers in the treatment of building effluents. Provide P&IDs and flow diagrams for all gaseous radwaste systems. Reference may be made to the appropriate sections of the PSAR. Show system and component capacities. Provide calculations for gas holdup systems, indicating holdup times, decay factors, and reserve capacity. Identify the normal mode of operation. List estimated quantities and flow rates from all sources, expected decontamination factors, and holdup times. Estimated quantities should be given in terms of cubic feet, total curie content, and activity concentration in microcurie per cubic centimeter ($\mu\text{Ci/cc}$).

Indicate which systems are used continuously and which are operated only under specific circumstances. Note those systems that are shared with other facilities at the site, those systems that are shared between separate buildings or between units, and also those that share a common effluent release point. Identify all gaseous radioactive effluent release points including height above grade, temperature, and exit velocity. Provide a summary tabulation of all radionuclides that will be discharged with each effluent stream, and provide the expected annual average release rate (Ci/yr).

3.7 EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAMS

Describe the program for monitoring and estimating the contribution of radioactivity to the environment for the operational phase of the

repository. Present the details of the approach, and the results obtained for determining the background levels and the estimate of subsequent contribution of the facility.

For the operational phase, identify the following programs:

3.7.1 Solid Waste Monitoring

Describe the procedures, equipment, and instrumentation used to monitor all radioactive solid waste.

3.7.2 Liquid Effluent Monitoring

Describe the features of the liquid monitoring and sampling systems to be used, their locations, and the items to be monitored. Discuss the frequency of sampling, the limits for action, and the procedures to be used to maintain continued integrity of analysis.

3.7.3 Gaseous Effluent Monitoring

Describe the features of the monitoring and sampling system to be used, their locations, and the items to be monitored. Discuss the frequency of sampling, the limits for action, and the procedures to be used to maintain integrity of analyses.

3.7.4 Environmental Monitoring

Describe in detail the program for monitoring possible contribution of radiation to the site and environs. Identify the samples of atmosphere, soil, flora, and fauna that will be taken; the frequency of obtaining the samples; the analyses to be performed; and the method of reporting. Include in this section the program for continuing meteorological data collection and evaluation throughout the operational phase.

3.8 DECOMMISSIONING PLANS

Provide information in the Environmental Report to respond to the typical requirements of 10 CFR 50, Appendix F, Section 4, "Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities," which requires that adequate provisions be made for decommissioning the repository after its normal operational life.

3.8.1 Decommissioning Alternatives

Compare and contrast the various alternate plans for decommissioning the repository. Include decontamination levels required for each alternative.

3.8.2 Decommissioning Program

Describe procedures for decommissioning the surface and subsurface facilities, disposing of contaminated surface objects in the mine, decontaminating those items that have intrinsic value or further utility, backfilling all tunnels, rooms, etc., sealing access and ventilation shafts, placing warning markers underground and on the surface, revegetating and restoring surface land contours, and the terminal phase surveillance program. Include plans and procedures to provide security measures for the post-decommissioning period.

Discuss the procedures and arrangements to decommission, decontaminate, or dispose of the facility components so that they will not present a hazard for an indeterminable period. This information should be provided in the appropriate sections as listed below.

3.8.2.1 Surface Facility

3.8.2.2 Shafts

3.8.2.3 Subsurface Facility

3.8.2.4 Remote Handling System

3.8.2.5 Systems

3.8.2.6 Security

3.8.2.7 Surveillance

3.9 REFERENCES

This section should contain a listing of all refernces used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

4.0 EFFECTS DURING SITE PREPARATION AND FACILITY CONSTRUCTION

This chapter will consider the short term impacts and mitigating measures for the time period covering site preparation and construction. The facility impacts (both radiological and nonradiological), the sensitivity of the human and ecosystem uses of the environment, and the capability of the environment to accept the impacts will be considered. On the basis of these considerations, predictions of potential impacts will be made. If a potential impact is nil, then this will be so stated. If a potential impact is significant and detrimental, then mitigation measures will be considered. If such mitigation measures are incorporated into the proposal, then the facility description will be revised to include these additional aspects. If it is determined that a potential impact is unavoidable, then a summary of the search for mitigation will be presented and in conclusion stated that the potential impact is unavoidable. In the case of each subsection, the final paragraph should either clearly state that there are no predicted impacts or enumerate the unavoidable adverse impacts and possible favorable impacts.

4.1 EFFECTS OF SURVEY ACTIVITIES

For the two following subsections identify those minor impacts due to survey activities. Specifically discuss increases in noise and dust levels, and biota disturbed, destroyed or relocated.

4.1.1 Cutting Access Trails and Lines of Site

4.1.2 Vehicular Access

4.2 EFFECTS OF SITE PREPARATION, SURFACE FACILITY

4.2.1 Description of Activities

Provide a detailed description of all activities associated with the site preparation necessary for the surface facility. Such activities could include, but are not limited to, excavation, grading, and creation of spoil piles.

4.2.2 Dust and Dust Control Program

Dust levels (concentrations) generated in loading, transporting, dumping, and storing mined materials, in processing materials, and caused by vehicular traffic should be described. Effectiveness of controls should be considered. This analysis should assess compliance with air quality standards.

4.2.3 Vegetation

Most vegetation impacts during the site preparation phase will be limited to the immediate construction area. Offsite impacts could occur (e.g., the construction of onsite access roads, transmission lines, etc.) and should be discussed in this section.

The impact analyses will be based upon data presented in Chapters 2 and 3. Based on the review and analysis of vegetation resources data and site development plans, each impact should be evaluated and categorized.

If unacceptable impacts are likely, alternative actions that would eliminate the impacts must be provided. If mitigation is deemed necessary to reduce adverse impacts to an acceptable level, appropriate mitigation techniques must be described. If anticipated impacts are judged acceptable, no further action is required.

4.2.4 Wildlife

The discussion of species-environment relationships should describe the area usage (e.g., habitat, breeding, etc.) for important species and include life histories of important regional animals.

The impact analyses will be based upon data presented in Chapters 2 and 3. Based on the review and analysis of wildlife resource data and site development plans, each impact should be evaluated and categorized.

The following types of information should be included:

- o A map showing known locations of critical habitats as defined by the U.S. Fish and Wildlife Service or habitats otherwise important to threatened or endangered wildlife.
- o Population estimates of any threatened or endangered species near the repository site.

If unacceptable impacts are likely, alternative actions that would eliminate the impacts must be provided. If mitigation is deemed

necessary to reduce adverse impacts to an acceptable level, appropriate mitigation techniques must be described. If anticipated impacts are judged acceptable no further action is required.

4.2.5 Chemicals Used

Describe the environmental effects due to the use of herbicides, solvents, vehicle lubricants, and products of evaporation/combustion during site preparation activities.

Describe the method(s) and/or procedures to be utilized to control the use of hazardous chemicals.

4.2.6 Prevention of Soil Erosion

Site preparation activities can result in changes in the physical and chemical characteristics of soil. These may range from soil loss to soil profile mixing, compaction, and changes in infiltration and permeability characteristics. Changes can also occur in productivity and revegetation potential due to contamination, leaching, or erosion.

All nonecological soil impacts directly or indirectly resulting from the site preparation of the facility (some of which are mentioned above) should be described. For each type of anticipated impact the data presented should include causes, magnitude, geographic extent (in acres and percentage of total site area), and duration. To the extent possible, the significance of each impact should be determined and discussed by relating it to natural levels of magnitude, extent, or duration. Any mitigating measures or reclamation plans (topsoil stockpiling, revegetation, etc.) designed to minimize or eliminate impacts on soils and to comply with any Federal or state laws or regulations should be described. Where appropriate, special emphasis should be given for preventing the chemical contamination of soils by runoff from spoil pile water, which might have a high concentration of dissolved solids and trace elements. The time needed to rehabilitate the soils to their natural state should be estimated. The expected effect of mitigating measures on the incidence, magnitude, and duration of impacts should also be considered.

4.2.7 Waste Disposal

Describe or list the types of waste generated during site preparation (i.e. used oil cans, grease cartridges, chemical drums, etc.). Discuss the method(s) to dispose of the above mentioned wastes. Detail any environmental impacts and plans for mitigating any adverse impacts due to waste disposal practices.

4.2.8 Radioactivity From Disturbed Soils

Potential site preparation-related impacts on background radiation levels (e.g., due to radioactivity in disturbed soils) should be estimated and presented here. Describe the soil monitoring program to be used during site preparation. If the impact is estimated to be negligible, then this conclusion should be substantiated.

If the impact is estimated to be substantial, provide the following information:

4.2.8.1 Soil Monitoring Program

Discuss the soil monitoring program used to detect any unusual radioactivity in the soils during site preparation. Indicate survey frequency intervals and typical areas to be surveyed.

4.2.8.2 Procedures if Encountered

Describe the methods used to reduce the radiological impact to the environment (including man) to acceptable levels as established by policies, codes, and/or regulations.

4.2.9 Aesthetic Impact

The visual quality of the landscape can be impacted by preparing the site of the repository. Consequently an analysis should be made of the aesthetic impact of such site preparation operations as land clearing, transportation route layout, establishment of spoil piles, dust, etc. Measures taken to mitigate impacts should be discussed and any unresolved impacts clearly stated.

4.2.10 Noise Impact

The noise impact should be described and quantified to the extent possible based upon site preparation activities described in this chapter. The noise estimation model should use the background sound levels from Section 2.11. The model should assume hemispherical sound propagation and some estimate of excess attenuation due to atmospheric absorption. Consideration should also be given to environmental factors affecting the actual sound levels, including vegetation and ground cover, topography, meteorological conditions, and seasonal conditions.

4.3 EFFECTS OF CONSTRUCTION, SURFACE FACILITY

This section should discuss the physicochemical changes and the energy releases due to the construction of the surface facility. Included should be results of calculations of environmental dispersion (e.g., isopleths of chemical concentrations, noise levels, etc.). These values should be compared with all applicable regulated standard values (except human-health-related air and water quality, to be considered later). If any standards are predicted to be exceeded, then mitigation measures should be sought and described. Unavoidable adverse effects should be considered as regulated standard values that cannot be met. In the absence of standards, unavoidable adverse impacts should be based on technical judgments.

4.3.1 Description of Activities

Provide a detailed description of all activities associated with the construction necessary for the surface facility.

4.3.2 Dust and Dust Control Program

Dust levels (concentrations) generated in loading, transporting, dumping, and storing mined materials, in processing materials, and caused by vehicular traffic during construction should be described.

4.3.3 Chemicals Used

Describe the environmental effects of the use of herbicides, solvents, vehicle lubricants, and products of evaporation/combustion during construction activities.

Describe the method(s) and/or procedures to be utilized to control the use of hazardous chemicals.

4.3.4 Waste Disposal

Describe or list the types of wastes generated during construction activities (i.e. used oil cans, grease cartridges, chemical drums, etc.). Discuss the method(s) to dispose of the above mentioned wastes. Detail any environmental impacts and plans for mitigating any adverse impacts due to waste disposal.

4.3.5 Aesthetic Impact

The visual quality of the landscape can be impacted by the construction of the repository. Consequently an analysis should be made of the aesthetic impact of such construction operations as transportation route construction, building erection, establishment of additional spoil piles, dust, etc. Measures taken to mitigate impacts should be discussed and any unresolved impacts clearly stated.

4.3.6 Noise Impact

The noise impact should be described and quantified to the extent possible based upon known sound levels of construction activities. The noise estimation model should use the background sound levels from section 2.11. The model should assume hemispherical sound propagation and some estimate of excess attenuation due to atmospheric absorption. Consideration should also be given to environmental factors affecting the actual sound levels, including vegetation and ground cover, topography, meteorological conditions, and seasonal conditions.

The noise impact of construction should be evaluated by comparing the predicted sound levels with applicable noise regulations and impact criteria.

4.4 EFFECTS OF CONSTRUCTION, SHAFTS

This section should discuss the physical and chemical changes and the energy releases consequent to the construction of the shafts. Included

should be results of calculations of environmental dispersion (e.g., isopleths of chemical concentrations, noise levels, etc.). These values should be compared with all applicable regulated standard values (except human-health-related air and water quality, to be considered later). If any standards are predicted to be exceeded, then mitigation measures should be sought and described. Unavoidable adverse effects should be considered as regulated standard values that cannot be met. In the absence of standards, unavoidable adverse impacts should be based on technical judgments.

4.4.1 Description of Activities

Provide a detailed description of all activities associated with the construction required for each shaft.

4.4.2 Chemicals Used

Describe the environmental effects expected to be caused by the chemicals used during the sinking of the shafts, i.e. drilling fluids.

Describe the method(s) and/or procedures to be utilized to minimize the adverse effects of chemical usage during shaft sinking.

4.4.3 Mud Pits

Describe any environmental impacts due to the construction of a mud pit for recycling drilling fluids. If the expected adverse impacts are considered to be substantial, provide information concerning the method(s) used to mitigate the adverse impacts.

4.4.4 Overburden Storage/Disposal

The following subsections should describe the environmental effects expected due to the spoil piles created by the shaft drilling activities.

4.4.4.1 Location and Description

Present a detailed description of the expected locations, dimensions, expected volumes, angle of repose, and chemical assay.

4.4.4.2 Dust and Dust Control Program

Expected dust levels (concentrations) attributed to the spoil piles resulting from the shaft drilling operations should be estimated. If necessary, discuss plans for mitigating the effects of fugitive particulates, i.e. the use of water.

4.4.4.3 Effects of Leaching

Discuss the environmental effects of natural leaching processes of the spoil piles. Information concerning chemical composition of the spoil piles will be found in Section 4.4.4.1.

4.4.4.4 Aesthetic Impact

The visual quality of the landscape can be impacted by the creation of spoil piles resulting from the shaft drilling operations. Consequently, an analysis should be made of the aesthetic impact of these spoil piles. Measures taken to mitigate aesthetic impacts should be discussed and any unresolved impacts clearly stated.

4.4.4.5 Spoils Disposal

The ultimate disposal plans for the spoil piles should be described in relationship to the expected environmental effects.

4.4.5 Noise Impact

The noise impact should be described and quantified to the extent possible based upon drilling activities. The noise estimation model should use the background sound levels from Section 2.11. The model should assume hemispherical sound propagation and some estimate of excess attenuation due to atmospheric absorption. Consideration should also be given to environmental factors affecting the actual sound levels, including vegetation and ground cover, topography, meteorological conditions, and seasonal conditions.

The noise impact of drilling operations should be evaluated by comparing the predicted sound levels with applicable noise regulations and impact criteria.

4.5 EFFECTS OF CONSTRUCTION, SUBSURFACE FACILITY

This section should discuss the physicochemical changes and the energy releases due to the construction of the subsurface facility. Included should be results of calculations of environmental dispersion (e.g., isopleths of chemical concentrations, noise levels, etc.). These values should be compared with all applicable regulated standard values (except human-health-related air and water quality, to be considered later). If any standards are predicted to be exceeded, then mitigation measures should be sought and described. Unavoidable adverse effects should be considered as regulated standard values that cannot be met. In the absence of standards, unavoidable adverse impacts should be based on technical judgments.

4.5.1 Description of Activities

Provide a detailed description of all activities associated with the construction required for the subsurface facilities.

4.5.2 Chemicals Used

Describe the environmental effects expected to be caused by the chemicals used during the mining of the subsurface facility, i.e. drilling fluids and explosives.

Describe the method(s) and/or procedures to be utilized to minimize the adverse effects of chemical usage during mining.

4.5.3 Overburden Storage/Disposal

The following subsections should describe the environmental effects expected due to the spoil piles created by the subsurface mining activities.

4.5.3.1 Location and Description

Present a detailed description of the expected locations, dimensions, expected volumes, angle of repose, and chemical assay.

4.5.3.2 Dust and Dust Control Program

Expected dust levels (concentrations) attributed to the spoil piles resulting from the subsurface mining operations should be estimated. If necessary, discuss plans for mitigating the effect of fugitive particulates, i.e. the use of water.

4.5.3.3 Effects of Leaching

Discuss the environmental effects of natural leaching processes of the spoil piles. Chemical information pertinent to this discussion will be found in Section 4.5.3.1

4.5.3.4 Aesthetic Impact

The visual quality of the landscape can be impacted by the creation of spoil piles resulting from the subsurface mining operations. Consequently an analysis should be made of the aesthetic impact of these spoil piles. Measures taken to mitigate aesthetic impacts should be discussed and any unresolved impacts clearly stated.

4.5.3.5 Spoils Disposal

The ultimate disposal plans for the spoil piles due to mining activities should be described in relationship to the expected environmental effects.

4.5.4 Noise Impact

The noise impact should be described and quantified to the extent possible based upon subsurface mining activities. The noise estimation model should use the background sound levels from Section 2.11. The model should assume hemispherical sound propagation and some estimate of excess attenuation due to atmospheric absorption. Consideration should also be given to environmental factors affecting the actual sound levels, including vegetation and ground cover, topography, meteorological conditions, and seasonal conditions.

The noise impact of subsurface mining should be evaluated by comparing the predicted sound levels with applicable noise regulations and impact criteria.

4.6 EFFECTS OF CONSTRUCTION, SYSTEMS

This section should discuss the physicochemical changes and the energy releases due to the construction of the support systems. Included should be results of calculations of environmental dispersion (e.g., isopleths of chemical concentrations, noise levels, etc.). These values should be compared with all applicable regulated standard values (except

human-health-related air and water quality, to be considered later). If any standards are predicted to be exceeded, then mitigation measures should be sought and described. Unavoidable adverse effects should be considered as regulated standard values that cannot be met. In the absence of standards, unavoidable adverse impacts should be based on technical judgments.

Provide this information as it relates to the following subsections.

4.6.1 Power Lines

4.6.2 Water Lines

4.6.3 Sewer Lines and Tile Fields

4.6.4 Dumps, Fills, and Borrow Pits

4.6.5 Railroad Spurs and Sidings

4.6.6 Roads

4.6.7 Perimeter Fences, Internal Fences, and Security Zones

4.6.8 Communication Equipment Installation

4.7 CONSTRUCTION IMPACT CONTROL PROGRAM

The construction permit may require certain actions on the part of the applicant to ensure that environmental controls to minimize impacts are carried out. In addition to the discussion of the effects of site preparation and construction, the applicant should furnish details of the program with which it plans to monitor those activities affecting site-related environmental quality. The applicant should state the specific nature of its control programs and the control procedures it intends to follow as a means of implementing adherence to environmental quality control limits, as applicable.

The applicant should describe measures designed to mitigate or reverse undesirable effects such as noise, erosion, dust, truck traffic, flooding, ground water level modification, and channel blockage. The description should include plans for landscape restoration, protection of natural drainage channels or development of appropriate substitutes, measures taken to control rainfall runoff, augmented water supply for affected surface and ground water users, and flood and pollution control.

The applicant should describe the means by which compliance with EPA's effluent limitation guidelines or new source performance standards (40 CFR Part 423) applicable to construction activities will be achieved.

Precautions for handling of fuels, lubricants, oily wastes, and other chemical waste should be included. Describe any other measures planned for the protection of fish and wildlife during construction.

The information should be provided in summary form in the following subsections.

4.7.1 Surface Facility

(Summarize mitigation plans previously discussed in Section 4.3)

4.7.2 Shafts

(Summarize mitigation plans previously discussed in Section 4.4)

4.7.3 Subsurface Facility

(Summarize mitigation plans previously discussed in Section 4.5)

4.7.4 Systems

(Summarize mitigation plans previously discussed in Section 4.6)

4.8 RESOURCES USED

Discuss the resources and quantity expected to be used during construction (e.g., land, water, energy, man-hours, concrete, irrecoverable metals, chemicals, lumber, biological and costs).

Provide this detailed information for each of the following subsections.

4.8.1 Surface Facility

4.8.2 Shafts

4.8.3 Subsurface Facility

4.8.4 Remote Handling System

4.8.5 Systems

4.9 DENIAL OF RESOURCES

For each of the following subsections characterize and quantify the resources denied (e.g., agricultural land, minerals, surface water, ground water, etc.) from other potential uses due to the construction of a repository for radioactive material.

4.9.1 Surface Resources

4.9.2 Subsurface Resources

4.10 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

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5.0 EFFECTS DURING FACILITY OPERATION

5.1 SURFACE FACILITY OPERATIONS

This section considers only those impacts associated with facility operation, i.e., the receipt and burial of radioactive material. While some construction of tunnels and sub-surface storage areas may be occurring during this phase, those impacts should be discussed under Chapter 4.0.

5.1.1 Radiological Effects

In this section, the applicant should consider impacts on man or on biota other than man that are attributable to the release of radioactive materials and to direct radiation from the facility. The biota to be considered are those species of local flora and local and migratory fauna defined as "important" in Section 2.5 and whose terrestrial and/or aquatic habitats provide the highest potential for radiation exposure. Estimates of the radiological impact on man via the most significant exposure pathways should be provided.

5.1.1.1 Source Terms

For each radioisotope of biological significance, describe the stored inventory and the characteristics of the isotope pertinent to its release during operations and its eventual biological impact.

5.1.1.2 Exposure Pathways

The various possible pathways for radiation exposure of the important local flora and local and migratory fauna should be identified and described in the text and flowcharts. The pathways should include the important routes of radionuclide translocation (including food chains leading to important species) to organisms or sites.

The various possible pathways for radiation exposure of man should also be identified and described in text and flowcharts. As a minimum, the following pathways should be evaluated: direct radiation from

radioactivity contained within the repository, shoreline fishing (radionuclides deposited in sediments), immersion in airborne effluents, and radionuclides deposited on the ground surface and vegetation, and internal exposure from inhalation of airborne effluents and from ingestion of milk, drinking water, fish and game, invertebrates, and plants. Identify any additional exposure pathways specific to the region around the site that could contribute 10% or more to either individual or population doses.

5.1.1.3 Transport Models and Assumptions

Mathematical and/or physical models may be required to predict the transport of liquid and airborne radioactive effluents. The size of the region to be simulated and the required level of detail will depend on the radionuclide in question, the quantity released, the surface water pathways, atmospheric conditions, and the temporal and spatial variability of important model parameters (e.g., diffusion coefficients).

Transport predictions will often require the use of different models, each applicable to a given region of the environmental pathway. In each case, the model should be described in detail. The description should include justification of all model input data and assumptions. The applicant should describe in detail the methods employed to obtain model parameters (e.g., diffusion coefficients).

In the case of physical models, the applicant should present detailed descriptions of the model facilities, scaling requirements, data collection and analysis techniques, and error estimates.

For liquid radwaste transport analysis pursuant to 49 CFR Part 190, a tabulation of the expected concentrations and travel times for each of the important radionuclides released to each important pathway to man should be provided on a monthly average basis for conditions anticipated during repository operation.

5.1.1.3.1 Surface Water Models

Models are herein classified into two categories: those that estimate physical effects using simplifying, conservative assumptions and those that are state-of-the-art attempts at realistically modeling physical effects. Predicting the transport of liquid radioactive effluents may require the use of both categories of models, each

applicable under different situations and for different regions of the environment. The applicant should discuss the range of applicability of the models used, the methods used in model calibration and verification, the error limits of the resulting predictions, and the input data. Basic hydrologic data is discussed in Section 2.7.

5.1.1.3.2 Groundwater Models

The general categories of models, as described for surface water in Section 5.1.1.3.1, are also applicable to groundwater models. Mathematical models may be used for predicting ground water use and flow and radionuclide transport in aquifers to provide the assessment typically required by 49 CFR Part 190. For groundwater use models, the size of the region to be simulated is the area within 80 km of the repository unless it can be clearly demonstrated that the region within repository influence is of smaller extent. For groundwater flow and transport models, the size of the region to be simulated and the required level of detail will depend on the radionuclide in question, the quantity released, potential groundwater pathways, and temporal and spatial variability of important model parameters (e.g., dispersion coefficients). In general, the size of the simulated region should encompass an area large enough to reach the nearest significant downgradient surface water body and/or downgradient water supply wells within 80 km of the repository.

Transport predictions will often require the use of different models, each applicable to a given region of the groundwater pathway. In each case, the model should be described in detail. The description of the model should include justification of all model input data and assumptions. When more than one model is used, also describe the operation required to use the output from the preceeding model as input to the succeeding model. The applicant should describe in detail the methods employed to obtain model parameters such as dispersion and distribution (sorption) coefficients. Baseline data for model parameters should be presented in Section 2.7. The techniques and results of both laboratory and field calibration and verification studies, including sensitivity analysis, should be presented for each model.

5.1.1.3.3 Lithologic Uptake Models

In some cases, a substantial portion of certain radionuclides released from the repository will be removed from solution. Consideration of such removal mechanisms may substantially change the ultimate calculated doses to man. If credit is claimed for reduction of radionuclide concentrations in surface waters by the mechanism of lithologic uptake, analysis and verification should be provided. Such analysis should include actual field and laboratory measurements to determine sorption and transport of radionuclide ions. The sampling and analyses should cover the area of significant influence of the repository and should consider seasonal changes.

Mathematical models may be used for calculating the removal of ions by lithologic and the transport of attached ions in the geologic media. Models should be verified by comparison to field studies (e.g., tracers) from water bodies having characteristics similar to those near the repository. Data should be provided to substantiate that the conditions postulated in the model will be typical of those at the site.

If the applicant elects to carry out an analysis of removal of radionuclide ions by lithologic uptake, the results should also be used to estimate the concentrations in the geologic media for other pathways to man, such as direct contact or uptake by benthic organisms. Regulatory guides are in preparation to establish both criteria and data collection requirements for lithologic uptake and transport models.

If credit is claimed for concentration reductions of radionuclides resulting from lithologic uptake and transport, results should be tabulated separately in the table requested in Section 5.1.1.3.

5.1.1.3.4 Atmospheric Dispersion Models

The models and assumptions used to determine air concentration and/or deposition should be described in detail and their validity and accuracy discussed. Guidance on typical models is provided in Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion from Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors." The meteorological data used in these models should be identified and consistent with Section 2.6. From the atmospheric transport and diffusion

models and meteorological data, provide estimates of relative concentrations (X/Q), where X and Q are expressed in units of curie per square meter (Ci/m^2) and Ci/yr , respectively, and/or relative annual (or seasonal) deposition (D/Q), where D is expressed in units of Ci/m^2-yr , at points of potential maximum concentration outside the site boundary, at points of estimated maximum individual exposure, and at points within a radial grid of sixteen $22\frac{1}{2}$ -degree sectors centered on true north and extending to a distance of 80 km from the repository. A set of data points should be located within each sector at increments of 0.4 km to a distance of 1.6 km from the repository, at increments of 0.8 km from a distance of 1.6 to 8 km, at increments of 4 km from a distance of 8 to 16 km, and at increments of 8 km thereafter to a distance of 80 km. Estimates of relative concentration (X/Q) for noble gas effluents and, if applicable, relative concentration (X/Q) depleted by deposition and relative deposition (D/Q) for radionuclide and particulate effluents should be provided at each of these grid points. In addition, averages of these X/Q and/or D/Q values between all adjacent grid points along the radials should be provided.

5.1.1.4 Dose Rate Estimates to Man

Calculate, using the above information provided in Section 5.1.1 and any other necessary supporting data, the total body and significant organ (including GI tract, thyroid, skin, and bone) doses (millirem/year) to individuals in the population within an 80-km radius from all exposure pathways, i.e., all sources of internal and external exposure. Provide details and models of the calculation as an appendix to the ER.

5.1.1.5 Dose Rate Estimates to Biota Other than Man

From considerations of the exposure pathways described in Section 5.1.1.2 and the distribution of facility-derived radioactivity in the environs, the applicant should estimate (1) the maximum radionuclide concentrations that may be present in important local flora and local and migratory fauna and (2) the internal dose rates (millirad/year) that may result from those concentrations. Values of bioaccumulation factors used in preparing the estimates should be based on site-specific data, if

available; otherwise, values from the literature may be used. The applicant should tabulate and reference the values of bioaccumulation factors used in the calculations. Dose rates to important local flora and local and migratory fauna that receive the highest external exposures should be provided along with a description of the calculational models.

5.1.1.6 Summary of Annual Radiation Doses

The applicant should present a table that summarizes the estimated annual radiation dose to the regional population (during commercial operation of the repository) from all repository-related sources, using values calculated in previous sections. The tabulation should include, out to a distance of 80 km from the site, (a) the total of the whole-body dose to the population (man-rem/year) from all receiving-water-related pathways, (b) the total of the whole-body doses to the population (man-rem/year) attributable to gaseous effluents, and (c) the total of the thyroid doses to the population (thyroid-rem/year) from radioiodines and particulates. The applicant should include a table comparing the calculated individual doses with the 49 CFR Part 190.

5.1.2 Nonradiological Effects

In this section, the applicant should describe impacts on man or on biota other than man that are attributable to the release of nonradioactive effluents (i.e., chemicals, biocides, etc.) from the repository.

5.1.2.1 Source Terms

Identify all sources of nonradioactive effluents (acids, solvents, and other chemicals not contaminated with radioactive materials). Itemize chemicals and materials as to storage and use location, quantities, and hazard potential (e.g., cleaning solutions, mine vehicle fuels, other fuels).

5.1.2.2 Escape Pathways

The various escape pathways for nonradioactive effluents to the environment should be identified and described in the text and

flowcharts. The escape pathways should include the important routes of translocation to organisms, the site, and man.

5.1.2.3 Transport Models and Assumptions

Discuss and reference where appropriate, the mathematical models used to evaluate the nonradiological impact to the environment and man. Similar models to those used in Section 5.1.1.3 to evaluate the radiological impacts should be used in this evaluation.

5.1.2.4 Estimated Concentrations to Man

Calculate, using the information in Section 5.1.2 and any other necessary supporting data the expected concentrations of nonradioactive effluents that result in exposures to man.

5.1.2.5 Estimated Concentrations to Biota Other than Man

From considerations of the escape pathways described in Section 5.1.2.2 and the distribution of facility-derived nonradioactivity in the environs, the applicant should estimate the maximum nonradionuclide concentrations that may be present in the local flora and fauna and migratory fauna. Values of bioaccumulation factors used in preparing the estimates should be based on site-specific data, if available; otherwise, values from the literature may be used. The applicant should tabulate and reference the values of bioaccumulation factors used in the calculations.

5.1.2.6 Summary of Nonradiological Effects and Allowable Concentrations

The applicant should present a table that summarizes the estimated annual concentrations to the regional population (including biota other than man) from all repository-related sources, using values calculated in the previous sections.

The concentration of effluents in surface water and ground water and atmospheric emissions should be compared with any applicable standards (e.g., drinking water standards and ambient air quality standards). Where national (EPA) standards do not exist, state standards may be available or those of a foreign country (e.g., Russia, Czechoslovakia, etc.) or international agency (i.e., World Health Organization) may be used.

5.1.3 Thermal Effects

In this section, the applicant should describe impacts on man or on biota other than man that are attributable to the thermal effects created by the emplacement of radioactive material in a deep geologic repository.

5.1.3.1 Effluent Limitations and Water Quality, Air Quality

Describe applicable Federal and state (40 CFR Part 423) effluent guidelines and the thermal standards or limitations applicable to the air and water to which the discharge is made (including maximum permissible temperature, maximum permissible increase, mixing zones, and maximum rates of increase and decrease) and whether and to what extent these standards or limitations have been approved by the Administrator of the Environmental Protection Agency in accordance with the Federal Water Pollution Control Act, as amended. Indicate whether the discharge could affect the quality of the air and waters of any other state or states.

If no thermal discharge(s) to water and the atmosphere will result from the repository operation, then an applicable statement should be made.

5.1.3.2 Physicochemical Effects

Describe the physicochemical effects that any heated effluent will have on the temperature of the receiving medium with respect to space and time. The predicted characteristics of the mixing zone and temperature changes in the receiving body as a whole, including seasonal effects, should be covered. Discuss any model studies and calculations that have been performed to determine these characteristics, giving references to reports that provide supporting details. Details of calculational methods used in predicting thermal plume configurations should be given in an appendix to the environmental report. The results should be portrayed in graphic form, showing isotherms in three dimensions for a range of conditions that form the basis for the estimation of ecological impact.

Where releases are determined to be affected by winds, a probability rose relating directions, extent of modification, and time should be included.

5.1.3.3 Biological Effects

Describe the effects of released heat on marine and freshwater life. Give the basis for the prediction of effects. In this discussion, appropriate references to the baseline ecological data presented in Section 2.5 should be made. Expected thermal effects should be related to the optimum and tolerance temperature ranges for important aquatic species (as defined in Section 2.5) and the food base that supports them. The evaluation should consider not only the mixing zone, but also the entire regional aquatic habitat potentially affected by operation of the proposed repository.

Potential hazards of the water intake and discharge structures (if applicable) to fish populations and food base organisms should be identified, and steps planned to measure and minimize the hazards should be discussed. Diversion techniques should be discussed in the light of information obtained from ecological studies on fish population, size, and habitats.

The applicant should discuss the potential biological effects of modifying the natural circulation of the water bodies (if applicable) affected by the repository, especially if water is withdrawn from one region or zone and discharged into another. This discussion should consider such factors as the alteration of the dissolved oxygen and nutrient content and distribution in the receiving water, as well as the effects of scouring and suspended sediments. Where natural salinity is modified by repository waterflow, the effects should be quantitatively investigated.

Facility induced changes in the temperature of the discharged water subsequent to environmental stabilization can affect aquatic life in the receiving body. Describe procedures for reducing thermal shock to aquatic organisms during operation. A discussion of operation with reduced circulator flow or increased temperature differentials should be specifically addressed to timing and extent to provide a basis for comparison of the effects of such operation with those of standard operating modes.

5.1.4 Other Effects

The applicant should discuss any effects of repository operation that do not clearly fall under any single topic of Sections 5.1.1 to 5.1.3. These may include changes in land and water use at the repository site,

interaction of the repository with other existing or projected neighboring facilities, effect of groundwater withdrawal on groundwater resources in the vicinity of the repository. Any features of the repository producing noise levels outside the suggested levels should be specifically identified and discussed in relation to adjacent occupancy, both day and night, based on measurements of preconstruction ambient levels. (Cross reference Section 2.11).

Additional effects to be considered should include wind and water erosion, vehicular effects, and nature forces/facility interactions.

5.1.5 Resources Used

Discuss in detail the resources and quantity expected to be used during repository operation, including but not necessarily limited to the following resources.

- o Land
- o Water
- o Energy
- o Man-hours
- o Irrecoverable Metals
- o Chemicals
- o Biological Resources
- o Costs

5.1.6 Conservation/Impact Reduction Program

Provide a summary of the plans and procedures for mitigating the environmental effects due to the operation of the repository in each of the respective subsections.

5.1.6.1 Radiological Effects

5.1.6.2 Nonradiological Effects

5.1.6.3 Thermal Effects

5.1.6.4 Other Effects

5.1.6.5 Resources Used

For each of the following sections provide the detailed information as established and outlined in Section 5.1.

5.2 SHAFT OPERATIONS

5.3 SUBSURFACE OPERATIONS

5.4 REMOTE HANDLING SYSTEM OPERATIONS

5.5 SYSTEMS OPERATIONS

5.6 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

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6.0 EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

This chapter should describe in detail the means by which the applicant collected the baseline data presented in other chapters and should describe the applicant's plans and programs for monitoring the environmental impacts of site preparation, repository construction, and repository operation.

Section 6.1 addresses the proposed program for assessing the characteristics of the site and the surrounding region before repository operation. The purpose of this program is to establish a reference framework for assessing subsequent environmental effects attributable to site preparation, repository construction, and repository operation.

The applicant should note two considerations pertinent to Section 6.1. First, a given environmental characteristic or parameter may or may not require assessment before site preparation and repository construction, depending on whether that particular characteristic or parameter may be altered at these stages. Second, in most instances this format indicates the specific environmental effects to be evaluated; consequently, the parameters to be measured are apparent. In some cases, the applicant may consider it necessary to establish a monitoring program based on identification of potential or possible effects not mentioned in this format. In such instances, the program should be described. The applicant should carefully review plans for the measurement of conditions existing prior to site preparation to ensure that these plans include all environmental parameters that must be subsequently monitored during repository operation (discussed in Section 6.2), as well as during site preparation and repository construction.

If, as permitted by 10 CFR Part 2, §2.101(a), the applicant chooses to make an early separate filing of the environmental report prior to obtaining and evaluating a full year's environmental data, particular attention should be paid to the description of sampling design, sampling frequency, and statistical methodology and validity (including calibration checks and standards) in order to justify the scope of the

proposed program, the timing and scheduling of the data collection, and other technical validation that will assure the NRC review staff that sufficient information will be available for the preparation of the Final Environmental Impact Statement.

This is especially critical if the timing of partial presentations under the procedure may be related to seasonal ecological factors such as migration or other phases of critical biological activity.

In all cases, estimate the statistical validity of any proposed sampling program in order to avoid unnecessary time delay during NRC review which might be associated with incomplete descriptions, invalid sampling locations, and level of sample replication. Information should be provided on instrument accuracy, sensitivity, and (especially for highly automated systems) reliability. Where standard analytical or sampling techniques can be identified, they need only be so identified and referenced.

For quantitative descriptions of samples collected within each area of interest and each time of interest, descriptive statistics should include, unless justifiably omitted, the mean, standard deviation, standard error, and a confidence interval for the mean. In each case the sample size should be clearly indicated. If diversity indices are used to describe a collection of aquatic or terrestrial organisms, the specific diversity indices used should be stated.

6.1 PREOPERATIONAL ENVIRONMENTAL PROGRAMS

The programs for collection of initial or baseline environmental data prior to operations should be described in sufficient detail to make it clear that the applicant has established a thorough and comprehensive approach to environmental assessment. The description of these programs should be confined principally to technical descriptions of technique, instrumentation, scheduling, and procedures.

Where an effect of site preparation or facility construction may alter a previously measured or observed environmental condition, the program for determining the modified condition should be described.

Where information from the literature has been used by the applicant, it should be concisely summarized and documented by reference to original data sources. Where the availability of original sources that support

important conclusions is limited, provide either extensive quotations or references to accessible secondary sources. In all cases, information derived from published results should be clearly distinguished from information derived from the applicant's field measurements.

Data from the preoperational program may not be available at the time of submission of the Environmental Report--Construction Permit Stage. Accordingly, the applicant should submit for Section 6.1, as a later supplement to the Environmental Report--Operating License Stage, 6 to 12 months of preoperational environmental radiological monitoring data. The minimum amount of preoperational data may be submitted if it includes data from a crop harvest and a complete grazing season. All media with a collection frequency less than semiannual (e.g., annual or once in 3 years) should be included in the 6 to 12 months of data submitted.

6.1.1 Hydrologic

6.1.1.1 Surface Water

When a body of surface water may be affected by the proposed facility or a practicable alternative, the applicant should describe the programs by which the background condition of the water and the related ecology were determined and reported in Section 2.7. The applicant should have sufficient data to permit NRC verification of any predictive computations or models used in the evaluation of environmental effects.

6.1.1.1.1 Physicochemical Parameters

The programs and methods for measuring physicochemical parameters of surface waters that may be affected by construction or operation of the facility should be described. The sampling program should be presented in sufficient detail to demonstrate its adequacy with respect both to spatial coverage (surface area and depth) and to temporal coverage (duration and sampling frequency), giving due consideration to seasonal effects. This discussion should include a description of the techniques used to investigate any condition that might lead to interactions with repository discharges, such as how the presence of impurities in a water body may react synergistically with heated effluent or how the heated

effluent may restrict mixing and dispersion of radioactive effluents. The applicant should describe any computational models and their bases and verification used in predicting effects described in Section 5.1.3.2.

6.1.1.1.2 Ecological Parameters

Describe the preoperational program used to determine the ecological characteristics presented in Section 2.5. Those portions of the program concerned with determining the presence and abundance of important aquatic and amphibious species (identified in Section 2.5.2) should be detailed in terms of frequency, pattern, and duration of observation. Describe how taxonomic determinations were made and validated. In this connection, discuss its reference collection of voucher specimens or other means whereby consistent identification will be ensured.

A description should be provided of the methods used, or to be used, for observing natural variations of ecological parameters. If these methods involve indicator organisms, the criteria for their selection should be presented. The discussion of methods should include estimates of standard error in making reported determinations.

The applicant should discuss the basis for its predictions of any nonlethal physiological and behavioral responses of important species which may be caused by construction or operation of the repository. This discussion should be appropriately correlated with the description of the monitoring program, including estimates of the standard error for each correlation.

Parameters of stress for important species (as defined in Section 2.5) that could be affected by repository discharges should be identified. The methodology for determining such parameters should be reviewed with respect to applicability to actual local conditions anticipated during operation, including interactive effects among multiple effluents and existing constituents of the surface water body concerned.

6.1.1.2 Subsurface Water

In those cases in which the proposed facility or a practicable design alternative may potentially affect local ground water or in which the groundwater environment may serve as a pathway to man, either directly or indirectly, the program leading to assessment of potential effects should be described.

6.1.1.2.1 Physicochemical Parameters

The properties and configuration of the local aquifer, variations (spatial and temporal) in groundwater levels, and groundwater quality data are discussed in sufficient detail in Section 2.7 to permit a reasonable projection of the effects of repository operation on the ground water. The methods used to obtain and reduce the data presented in Section 2.7 should be described, including instrumentation (suggested criteria will be presented in a forthcoming NRC regulatory guide on hydrologic data collection).

6.1.1.2.2 Models and Assumptions

Models may be used to predict effects such as changes in groundwater levels, dispersion of contaminants, and eventual transport through aquifers to surface water bodies. The models should be described and supporting evidence for their reliability and validity presented.

6.1.2 Atmospheric

6.1.2.1 Air Quality

Describe the program for obtaining information on local air quality and local and regional meteorology. Guidance on an acceptable onsite meteorological measurement program and on data format is presented in Regulatory Guide 1.23 (Safety Guide 23), "Onsite Meteorological Programs." The description should show the basis for predicting such effects as the dispersion of gaseous effluents to a distance of 80 km from the repository and the alteration of local climate (e.g., fogging, icing, precipitation augmentation, or other phenomena) and should present the methodology for gathering baseline data.

6.1.2.2 Meteorology

Identify sources of meteorological data used in the atmospheric transport models reported in Chapter 5.0. Locations and elevations of observation stations, instrumentation, and frequency and duration of measurements should be specified both for the applicant's measuring activities and for activities of governmental agencies or other organizations on whose information the applicant intends to rely. For the applicant's preoperational and operational programs, the applicant should include descriptions of instruments, performance specifications, calibration and maintenance procedures, data output and recording systems and locations, and data analysis procedures.

6.1.2.3 Models and Assumptions

Any models used, either to derive estimates of basic meteorological information or to estimate the effects of effluent systems, should be described in detail and their validity and accuracy discussed. Guidance on typical atmospheric transport and diffusion models is providing in Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion for Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors."

6.1.3 Geologic

Data collection and evaluation programs concerning the terrestrial environment of the proposed facility should be described and justified with regard to both scope and methodology.

6.1.3.1 Surface Geology and Soils

Those surface geological and soil studies designed to determine the environmental impact of the construction or operation of the facility should be described. The description should include identification of the sampling pattern and the justification for its selection, the sampling method, preanalysis treatment, and analytical techniques. Other surface geological and soil studies (e.g., conducted in support of safety analyses) should be briefly summarized if relevant.

6.1.3.2 Deep Subsurface Geology

The subsurface geological studies designed to determine the environmental impact of the construction or operation of the facility should be described. The description should include identification of the borehole sampling pattern and the justification for its selection, the sampling method, preanalysis treatment, and analytical techniques. Any other relevant subsurface geological studies (e.g., conducted to support safety analyses) should be briefly summarized.

6.1.3.3 Ecological Parameters

In this section, discuss the program used to assess the ecological characteristics of the site, with primary reference to important terrestrial biota identified in Section 2.5.1. In general, the considerations involved are similar to those suggested in connection with aquatic biota (Section 6.1.1.1.2). However, the differences in habitat, differences in animal physiology, and other pertinent factors will, of necessity, influence the design of the assessment program. Present, as in Section 6.1.1.1.2, an analysis of the program in terms of taxonomic validation, rationale for its predictive aspects, and the details of its methodology.

6.1.4 Ecology

Describe in detail the preoperational program designed to determine the environmental impact of the construction and operation of the repository on the ecological resources. The description should be covered in the appropriate subsection listed below and cross referenced to Section 2.5.

6.1.4.1 Terrestrial

6.1.4.2 Aquatic

6.1.5 Demographic

Describe the program for identifying and acquiring demographic data for the region as reported in Section 2.2.

Sources of information should be identified. Methods used to forecast probable changes in demographic trends should be described.

6.1.6 Radiological

The preoperational program should be described in detail in the Environmental Report--Construction Permit Stage. Specific information should be provided on (a) the types of samples to be collected, (b) sampling locations clearly shown on a map keyed to a table listing sampling locations as a function of direction and distance from the proposed site, (c) analyses to be performed on each sample, (d) general types of sample collection equipment, (e) sample collection and analysis frequency, (f) lower limit of detection for each analysis, and (g) the approximate starting date and duration of the program. The discussion should include the justification for the choice of sampling sites, analyses, and sampling frequencies. Review of this description will be facilitated if the applicant presents a tabular summary of the program.

The applicant should also describe how it expects to extend the preoperational program into the operational phase and in what manner the results of the preoperational program may be used to effect the design of the operational program. Typical guidance for both the preoperational program and operational program is provided in Regulatory Guide 4.1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants." Additional guidance is provided in Regulatory Guide 4.8, "Environmental Technical Specifications for Nuclear Power Plants." In addition, EPA report ORP/SID 72.2, Environmental Radioactivity Surveillance Guide, recommends methods for conducting a minimum level of environmental radiation surveillance outside the repository site boundary.

Summarize any information available from the literature regarding background radiological characteristics of the site which were considered in designing the program (reference may be made to Section 2.12 as appropriate).

The Environmental Report--Operating License Stage should discuss the preoperational program which has gone or will soon go into operation. Any changes in the program (relative to the description supplied at the construction permit stage) should be discussed and the rationale provided for such changes.

6.2 PROPOSED OPERATIONAL MONITORING PROGRAMS

Operational monitoring programs may not be fully developed at the time of applying for a construction permit. The applicant should, to the

extent feasible, describe the general scope and objectives of its intended programs and provide a tentative listing of parameters that it believes should be monitored for detailed evaluation. This listing should include numerical excerpts from water or air standards against which the proposed monitoring program will be measured as understood at the time of initial submission of the ER. The listing should also include parameters that are important for the models described in Chapter 5.0.

Regulatory Guide 4.8, "Environmental Technical Specifications for Nuclear Power Plants," describes typical information to be submitted with an application for an operating license.

In the Environmental Report--Construction Permit Stage, the operational program need only be discussed to the extent that it is expected to differ (if at all) from the ongoing preoperational program, such as the inclusion of a census of dairy cattle and vegetable gardens. If, in the Environmental Report--Operating License Stage, there are no differences between the preoperational programs, the applicant need only make a statement to that effect and provide a commitment to conduct the operational program. If there are differences in the operational program, the applicant should describe the reasons for the differences. The applicant should also discuss any plans and rationale for updating the program during repository operation.

Final approval of the operational program, as described completely in the proposed environmental technical specifications, will be given at the end of the technical specification review process.

If the proposed operational monitoring programs differ from the preoperational monitoring programs, provide a detailed description of the proposed operational monitoring programs following the format described in Section 6.1.

6.3 POST OPERATIONAL MONITORING PROGRAM

Describe in detail the programs which will monitor possible contribution of radiation to the site and environs following decommissioning of facilities (i.e., the terminal isolation phase). Identify any samples of atmosphere, soil, ground water, flora, and fauna which will be taken, the frequency of sampling, sample analyses to be

performed, instrumentation and calibration, and documentation and reporting procedures. Provide a description and location of each instrument and piece of equipment, the maintenance, inspection, and calibration programs.

6.4 RELATED ENVIRONMENTAL MONITORING PROGRAMS BY OTHER AGENCIES

When the repository site lies within a region for which environmental measurement or monitoring programs are carried out by public agencies or other agencies not directly supported by the applicant, any such related programs known to the applicant should be identified and discussed. Relevance of such independent findings to the proposed facility's effects should be described, and plans for exchange of information, if any, should be presented. Agencies responsible for the programs should be identified and, to the extent possible, the procedures and methodologies employed should be briefly described. These agencies may have developed and verified mathematical or physical models that encompass the site area and the surrounding water environs comparable to those discussed in Chapter 5.0. Such models may be used either directly or with minor modifications. When such models are used in support of liquid transport analyses of radionuclide releases, the same data and technical bases as suggested in Chapter 5.0 should be furnished.

6.5 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

7.0 ENVIRONMENTAL EFFECTS OF ACCIDENTS

This chapter will be based upon the event scenarios to be employed in the Preliminary Safety Analysis Report (PSAR) which pertain to the construction, operation and decommissioning phases (the scenarios may be referenced when appropriate). An appropriate indicator or description of the probability of each event will also be abstracted from the PSAR. The methodology for the assessment of health impacts (i.e., the maximum dose to an individual and the population dose) will be reviewed, the conservative assumptions employed in the safety analysis will be replaced with realistic assumptions, and the impacts will be determined.

7.1 CONSTRUCTION PHASE ACCIDENTS HAVING ENVIRONMENTAL CONSEQUENCES

This section should summarize the methodology for assessment, probability of occurrence, postulated consequences, and the risk (probability times consequence) associated with construction phase accidents. The following topics should be addressed to provide the summary discussion in each of the subsections listed below.

- o Event Scenarios
- o Likelihood of Occurrence
- o Assumed Consequences
- o Risk Analysis Summary

7.1.1 Surface Facility Accidents

7.1.2 Shaft Accidents

7.1.3 Subsurface Facility Accidents

7.1.4 Systems Accidents

7.2 OPERATIONAL PHASE ACCIDENTS HAVING ENVIRONMENTAL CONSEQUENCES

This section should summarize the assessment methodology, occurrence probabilities, postulated consequences and the risk (probability times consequence) associated with operational phase accidents.

7.2.1 Accidents Involving Nonradioactive Material

Provide the summary information outlined in Section 7.2 for those operational accidents involving nonradioactive material. The following topics should be addressed to provide the summary discussion in each of the subsections listed below.

- o Event Scenarios
- o Likelihood of Occurrence
- o Assumed Consequences
- o Risk Analysis Summary

7.2.1.1 Surface Facility Accidents

7.2.1.2 Shaft Accidents

7.2.1.3 Subsurface Facility Accidents

7.2.1.4 Remote Handling System Accidents

7.2.1.5 Systems Accidents

7.2.2 Accidents Involving Radioactive Material

For each of the following subsections provide the summary information outlined in Section 7.2 for those operational accidents involving radioactive materials. The following topic should be addressed to

provide the summary discussion in each of the subsections listed below.

- o Event Scenarios
- o Likelihood of Occurrence
- o Assumed Consequences
- o Risk Analysis Summary

7.2.2.1 Surface Facility Accidents

7.2.2.2 Shaft Accidents

7.2.2.3 Subsurface Facility Accidents

7.2.2.4 Remote Handling System Accidents

7.2.2.5 Systems Accidents

7.2.2.6 Onsite Transportation Accidents

7.3 TERMINAL ISOLATION PHASE ACCIDENTS HAVING ENVIRONMENTAL CONSEQUENCES

It is expected that the probable consequences during the very long (terminal isolation phase) time frame are nil. The nature of the very long time considerations are otherwise generally similar to those above for abnormal events during operation and for improbable events during an indeterminable period after emplacement. It is expected that the analysis will take the form of scenarios which, together, provide an envelope of possibilities and therefore bound the problem.

The PSAR planning will have generated scenarios and methodologies pertinent to the very long term; this effort should provide essential input to this section. However, the PSAR planning may or may not provide specific means to quantitatively assess very long term impacts. The authors should review the scenarios developed for safety analyses and determine case-by-case whether they are useful for developing a reasonable envelope of environmental impacts.

If the review of the safety analyses section(s) of the PSAR warrants additional discussion of the environmental consequences during the

terminal isolation phase, the summary information outlined in Section 7.2 should be provided in the following subsections.

- o Event Scenarios
- o Likelihood of Occurrence
- o Assumed Consequences
- o Risk Analysis Summary

7.4 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

8.0 ECONOMIC AND SOCIAL EFFECTS OF FACILITY CONSTRUCTION AND OPERATION

This chapter should describe the major activities associated with the construction and operation of a repository that can affect the human environment in local communities. The use of land for the repository is a commitment of resources and may directly require the displacement of people and existing land uses. The repository may also alter the visual quality of the area.

The immigration of workers and their families to meet labor needs during the construction and operation phases can indirectly affect the demand for housing, education programs, economic conditions, and other aspects of local and regional communities. Furthermore, secondary or induced population growth and land use development related to a repository may have additional impacts on the communities involved.

Other significant impacts may occur due to the transportation of construction materials and the movement of workers to and from the site. Impacts may involve accessibility to residential and other areas, traffic flows, and road maintenance programs.

These and all other potential construction and operation related impacts should be assessed to determine avoidable and unavoidable adverse impacts, favorable impacts, and irreversible and irretrievable commitments of land and socioeconomic resources. Impacts should be identified by cause, duration, geographic extent, magnitude, frequency, or other measures as appropriate. Interrelationships among impacts, especially unavoidable adverse ones, should also be assessed.

Mitigation or enhancement measures should be formulated for all impacts. Specific means for ameliorating or resolving concerns and problems associated with unavoidable adverse impacts are especially important. Descriptions of these measures should include agency responsibilities; policies, plans, and programs; manpower and financial requirements; and implementation schedules, among others.

8.1 GENERAL SOCIOECONOMIC IMPACTS

The socioeconomic impact analysis should assess the ability of local economies and social structures to meet the labor and capital requirements associated with direct and induced development that may occur due to the construction and operation of a repository.

Analytical methods that could be utilized to determine the types and levels of economic impacts include shift share, economic base, and input/output analyses. These as well as other methods and techniques could be used to assess effects on different sectors of the economy, the range of job opportunities, and overall economic growth and stability.

All major direct and indirect impacts on socioeconomic characteristics and their interrelationships with other parameters - such as the fiscal capacity of local taxing jurisdictions, the housing industry, and land use development - should be addressed.

8.1.1 Employment and Population

The construction and operation of a repository and associated development may have direct and indirect impacts on the availability of labor, the level and distribution of income, and other characteristics of the economic base.

The number, composition, and distribution of population in nearby communities may be affected by the construction and operation labor forces as well as by secondary or induced population growth. To assess changes in the size, character, and distribution of local and regional populations, standard variables such as changes in fertility, mortality, and net migration as well as employment turnover and the replacement and relocation of workers should be considered in determining impacts. Demographic impacts should be described by the smallest political subdivision appropriate to the specific communities involved. This description should include a characterization of both the change in percentage and absolute number of people that will reside in the affected communities. Results of this demographic impact should largely form the basis for determining the effects of changes in population on other socioeconomic parameters, such as community services, housing, and land use patterns, among others described in this chapter.

8.1.2 Social Environment

The overall social impacts on communities affected by the repository should be assessed for the existing resident populations and for the immigrating labor force and their families. Impacts on community cohesion, cultural practices, social service programs, citizen involvement in community affairs, general everyday living habits, and other factors should be analyzed. The analysis should also include a description and assessment of the institutional-organizational processes within which impacts may occur.

8.2 HOUSING AND LAND USE

8.2.1 Housing

Demographic, economic, and other conditions associated with the construction and operation of a repository can affect the quality, cost, and type of housing available. For local communities likely to be affected, an assessment of housing supply-demand relationships should be undertaken. This may include an evaluation of impacts on housing programs, costs, and availability; the home-building industry; financial institutions involved in the housing market; land use patterns; and other parameters.

8.2.2 Land Use

Land uses could be directly and indirectly affected by the construction and operation of a repository. Direct impacts such as the displacement of land uses in and near the repository site should be assessed. Any land uses having unique or otherwise significant value to local and regional communities and the nation need to be specifically addressed.

In addition, an assessment should be made of repository impact on the formulation, administration, and implementation of land use controls in affected communities as appropriate.

8.3 PRIVATE SECTOR

Provide an assessment of the socioeconomic impacts to the private sector of the local community due to the construction and operation of a repository. Such impacts should be described for the following components of the private sector.

8.3.1 Industrial Activities

8.3.2 Retail Trade and Services

8.4 COMMUNITY FACILITIES

Community facilities and associated services are important components of all local communities. The change in the socioeconomic status of the following parameters: education; utilities; fire and police protection; health care; sanitary and storm water sewerage; water supply; solid waste disposal; parks and recreation; etc., should be described.

Provide these descriptions according to the following outline.

8.4.1 Education

8.4.2 Utilities

8.4.3 Fire and Police Protection

8.4.4 Health Care

8.4.5 Parks and Recreation

8.5 TRANSPORTATION

The construction and operation of a repository, along with the associated immigrating population, may affect the location, carrying capacity, condition, and maintenance and capital cost requirements of transportation facilities. These public facilities include roads and highways as well as railroads. The particular geographical setting of

the repository and the availability of these transportation facilities may influence the level of detail required for the impact analyses. Roads, highways, railroads, commercial waterways, and air transportation should be discussed as outlined below.

Major impacts on individual segments as well as the network of roads and highways should be evaluated. These impacts may be attributable to an increase in automobile and truck traffic associated with the disposal of waste rock material and construction supply requirements, right-of-way relocations resulting from site development, and the attendant local population expansion.

Impacts on railroads, especially those related to the shipment of radioactive materials, should also be assessed for local and regional communities. In addition, any significant impacts on navigable waterways and port facilities should be considered.

8.5.1 Roads

8.5.2 Highways

8.5.3 Railroads

8.5.4 Commercial Waterways

8.5.5 Air Transportation

8.6 GOVERNMENT

8.6.1 Projected Revenues

The magnitude of the anticipated revenues to be received by local and national governmental organizations should be discussed in detail.

8.6.2 Projected Expenditures

The magnitude of the anticipated expenditures to be made by local and national governmental organizations should be discussed in detail.

8.7 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

9.0 LONG-TERM EFFECTS

Anticipated environmental changes during the long-term (post decommissioning) will be assessed to determine long-term unavoidable adverse impacts and resources committed. Possibilities for mitigation of the long-term impacts should be discussed. Uncertainties, particularly in health impacts, should be clearly identified.

The estimation of impacts and conception of mitigation measures applicable during a period of centuries will be of more importance (because there is more radioactivity to be concerned about) and more accurate (because the pertinent environments will not deviate grossly from present environments) than the estimates of the very long-term.

9.1 EFFECTS OF DECOMMISSIONING AND DISMANTLING

Describe the plans and policies regarding the actions to be taken at the end of the repository's operational life. Information should be provided on the long-term uses of the land, the expected environmental consequences of decommissioning, and an estimate of the monetary costs involved. Discuss the consideration given in the design of the repository and its auxiliary systems relative to eventual decommissioning, the amount of equipment and buildings to be removed, and the expected condition of the site after decommissioning. It is understood that the decommissioning plans and intentions of applicants for a construction permit may not be fully developed at the time of filing. However, since the environmental impact of terminating repository operation is, in part, determined by repository design, applicants should give attention to the subject in the project planning.

Present the planned program for decommissioning the repository after its normal operational life and any adverse environmental impacts. Describe procedures for dismantling the surface facility, disposing of contaminated surface objects in the mine, decontaminating those items that have intrinsic value or further utility, sealing all tunnels, rooms, access and ventilation shafts, etc., placing warning markers underground and on the surface, revegetating and restoring surface land contours, and resources committed. For the discussion of resources committed, utilize the format as developed in Section 4.8.

Discuss the procedures and arrangements to decontaminate or dispose of the facility components so that they will not present a hazard for an indeterminable period.

Provide the above information as appropriate in the following outline.

9.1.1 Surface Facility

9.1.2 Shafts

9.1.3 Subsurface Facility

9.1.4 Remote Handling System

9.1.5 Systems

9.2 ANTICIPATED TERMINAL ISOLATION EFFECTS

Present those items of environmental concern that may be considered normal to terminal waste isolation. Include all predictable processes that would not be considered in Chapter 7.0 of the ER and Chapter 9.0 of the PSAR as abnormal, accident or disruptive events. The material presented in this portion of the ER should relate the time-dependent processes in their relationship to normal isolation effects.

9.2.1 Radiological Effects

9.2.1.1 Radioactive Material-Container Interaction

For all radioactive material categories and their respective containers show how the containers and their contents interact. Show thermal effects on temperature, pressurization, chemical reactions, volatilization, and container strength. Consider the effects of radiation on these relationships. Consider air and water intrusion on the container-radioactive material system.

9.2.1.2 Radioactive Material-Media Interaction

9.2.1.2.1 Radioactive Material-Pore Fluid Interaction

Discuss the effect of those pore fluids near the disposal location. Determine the composition of the pore fluids and pore fluid flow patterns in the formation. Identify pore fluid effects on the radioactive material, such as ion exchange, leaching, and transport. Evaluate the effects of temperature and pressure gradients.

9.2.1.2.2 Thermal Effects

Discuss the effect on the host rock of the heat evolved by radionuclide decay. Determine the temperature change of the host rock versus time. Identify transformations and modifications of the surrounding medium caused by the temperature increase, such as release of volatiles by the host rock, fracturing, phase changes of the minerals in the rock, changes in composition of the rock, local melting, and any other effects produced by the temperature change. Illustrate the anticipated thermal profiles.

9.2.1.2.3 Changes in In Situ Stress Fields

Identify how the stresses at the radioactive material storage location may change because of the increased temperature and release of volatiles. Evaluate the effects of stress changes on any pre-existing fractures and their potential for creating new fractures. Determine the effects of stress change on radioactive material processes and interactions. Determine effects on pore fluid flow.

9.2.1.2.4 Radiation Effects

Determine the effect of radiation from the radionuclide decay on the container materials and the host rock. Identify changes in the structural or mechanical properties of the container materials and the rock. Consider the effect of radiation on chemical reactions due to ionization of the interacting materials.

9.2.1.2.5 Natural Intrusions

Discuss the effect of both air and water, separately or together, on the various radioactive material-media interactions. Consider increased reaction rates, reaction byproducts, pressurization, thermal gradients, etc.

9.2.1.3 Energy Dissipation

Show the modes of dissipation of the energy resulting from radioactive decay, corrosion processes, and any other repository processes.

9.2.1.4 Nuclide Migration

Show the pathways for nuclide migration from the storage area. Identify the motivation that would drive these materials on these pathways. Identify gaseous, liquid, and particulate migrations and their related transport media. Where applicable, indicate the migration rates. If appropriate, relate to individual nuclides, radioactive-material forms or cause for the migration.

9.2.1.5 Estimated Dose Due to Long-Term Radiological Effects

Present the man-rem annual exposures estimated to be attributable to long-term radiological parameters in each of 16 compass sectors about the facility between each of the arcs having the radii; 1, 3, 5, 7, 8, 15, 30, 40, 60, and 80 km.

Provide details of assumptions, and give sample calculations with emphasis on:

9.2.1.5.1 Source Terms

9.2.1.5.2 Exposure Pathways

9.2.1.5.3 Transport Models and Assumptions

9.2.1.5.4 Dose Rate Estimates to Man

9.2.1.5.5 Dose Rate Estimates to Biota Other than Man

9.2.1.5.6 Summary of Radiological Effects and Allowable Doses

Cross reference Section 5.1 for typical analytical methods to be used in this evaluation. Data for this evaluation should be obtained from Section 9.2.

9.2.1.6 Structure and Subsidence

This section deals with the potential adverse impact of the initiation of subsidence or collapse processes during the terminal isolation phase. Rock strata subsidence can occur in only a portion or in the complete rock column overlying the repository mine cavity and can even extend to the land surface. Subsidence leads to rock deformation, producing various structures such as extensive fracturing of strata remaining in position, faulting or slipping of rock strata along fractures, discontinuities of strata and anomalous dips of strata due to letdown or collapse of large blocks of rock, and extreme fragmentation due to the collapse or caving in of rock into cavities. The magnitude, extent, and duration of these impacts have a complex relationship with the size of the repository mine cavity, support structures within the mine, provisions for cavity backfill, depth beneath the surface, and overlying rock type. Subsidence is also responsible for subsequent impacts on the terrain, groundwater and surface water resources, terrestrial ecosystems, and land use. Structure impacts also include the creation of man-made structures such as mine shafts, boreholes, and mined cavities. These structures would extend deep into the rock column, would interconnect the subsurface repository with all overlying strata and the land surface, and could cause subsequent impacts on surface water and groundwater resources.

Expected subsidence, if any, should be discussed in this section. If no subsidence is expected, the rationale for this prediction should be thoroughly discussed.

9.3 LONG-TERM MONITORING AND SURVEILLANCE PROGRAM

9.3.1 Program Description

Provide a summary description of the programs that will monitor the contribution of radiation to the environment during the terminal isolation phase as described in Section 6.3.

9.3.2 Capabilities

The capability to accurately detect minute variations in the normal radiological background should be carefully described. Limitations to the capability of the program should be discussed as well

as those steps taken to reduce the effects of the identified limitations. The most important limitation to this type of long-term program may be the changing governmental structure. Describe any special plans necessary to aid the continuation of the program through governmental structure changes.

9.3.3 Cost

The cost of the long-term monitoring and surveillance program should be quantified in current dollars. Sources of these funds should be identified in this section. Special interfaces between state, county, and Federal sources should be identified.

9.4 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

10.0 UNAVOIDABLE ADVERSE EFFECTS

The unavoidable adverse effects and impacts previously identified in Chapters 4.0 and 5.0 will be collated here in terms of when and where they occur. Each section in this chapter should conclude with clearly identified unavoidable effects or a statement that there are none. Each of these identified effects will then appear in the following outline.

10.1 SUMMARY OF ADVERSE CONSTRUCTION EFFECTS

In this section, the unavoidable adverse effects described in Chapter 4.0, will be summarized and the major ones differentiated from the minor ones in each of the following subsections. If appropriate, a tabular presentation should be provided.

10.1.1 Surface Facility

10.1.2 Shafts

10.1.3 Subsurface Facility

10.1.4 Systems

10.2 SUMMARY OF ADVERSE OPERATIONAL EFFECTS

In this section, the unavoidable adverse effects described in Chapter 5.0, will be summarized and the major ones differentiated from the minor ones. If appropriate, a tabular presentation should be provided. This information should be provided in the appropriate subsections listed below.

10.2.1 Surface Facility

10.2.2 Shafts

10.2.3 Subsurface Facility

10.2.4 Remote Handling System

10.2.5 Systems

10.3 SUMMARY OF ADVERSE DECOMMISSIONING AND DECONTAMINATION EFFECTS

Summarize the unavoidable adverse effects described in Section 9.1. Major effects should be differentiated from the minor effects. If appropriate, a tabular presentation should be provided. This information should be provided in the appropriate subsections.

10.3.1 Surface Facility

10.3.2 Shafts

10.3.3 Subsurface Facility

10.3.4 Remote Handling System

10.3.5 Systems

10.4 SUMMARY OF ADVERSE LONG-TERM EFFECTS

Provide in summary form, the unavoidable adverse effects described in Section 9.2. If appropriate, a tabular presentation should be provided.

10.5 REFERENCES

* This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

11.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Any irreversible and irretrievable commitments of resources due to repository construction, operation, decontamination and decommissioning, and the terminal isolation phase should be summarized. This discussion should include both direct commitments, such as depletion of mineral resources, and irreversible environmental losses, such as destruction of wildlife habitat and consumptive use or diversion of water.

In this discussion, discuss lost resources from the viewpoints of both relative impacts and long-term net effects. As an example of relative impact assessment, the loss of two thousand fish of a given species could represent quite different degrees of significance, depending on the total population in the immediate region. Such a loss, however, in the case of a small local population, could be less serious if the same species were abundant in neighboring regions. Similarly, the loss of a given area of highly desirable land should be evaluated in terms of the total amount of such land in the environs. These relative assessments should accordingly include statements expressed in percentage terms in which the amount of expected resource loss is related to the total resource in the immediate region and in which the total in the immediate region is related to that in surrounding regions. The latter should be specified in terms of areas and distances from the site.

Typical information concerning commitment of resources is contained in Regulatory Guide 4.10, "Irreversible and Irretrievable Commitments of Material Resources."

11.1 SUMMARY OF RESOURCES AND ENERGY IRRETRIEVABLY COMMITTED

This section will present a summary discussion of commitments of resources which are identified in Chapters 4.0, 5.0, and 9.0. Specific resource commitments to be identified shall include, but not necessarily be limited to, the following resources.

- o Land
- o Water
- o Energy

- o Man-hours
- o Irrecoverable Metals
- o Chemicals
- o Biological
- o Costs

11.1.1 Construction

In Section 4.8, the quantities of resources used in construction of a repository are presented and discussed. A brief listing of applicable resources used and amounts listed above should be presented here as appropriate to the following breakdown.

11.1.1.1 Surface Facility

11.1.1.2 Shafts

11.1.1.3 Subsurface Facility

11.1.1.4 Remote Handling System

11.1.1.5 Systems

11.1.2 Operation

Utilize the description of resources committed during the operation of the repository (see Sections 5.1.5 to 5.5.5) to develop a summary of the committed resources. List the resources and amounts committed according to the following breakdown.

11.1.2.1 Surface Facility

11.1.2.2 Shafts

11.1.2.3 Subsurface Facility

11.1.2.4 Remote Handling System

11.1.2.5 Systems

11.1.3 Decontamination and Decommissioning

During the decontamination and decommissioning efforts for the repository, resources may be used. Summarize the resources used and amounts committed according to the following breakdown. (See Section 9.1)

11.1.3.1 Surface Facility

11.1.3.2 Shafts

11.1.3.3 Subsurface Facility

11.1.3.4 Remote Handling System

11.1.3.5 Systems

11.2 REFERENCES

This section should contain a listing of all references used in the preparation of the chapter. All references should be numbered in sequence of appearance in the chapter.

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12.0 RELATION OF PROPOSED ACTION TO LAND USE PLANS, POLICIES, AND CONTROLS

The potential conflicts of the proposed repository with Federal, state, regional, or local plans and policies and how any conflicts will be mitigated or resolved should be described.

12.1 SUMMARY OF EXISTING LAND USE PLANS

Describe any existing land use plans at or near the repository site. Identify zoning ordinances, proposed archeological excavations, mineral rights and exploration, etc., that may affect the location of the repository.

12.2 COMPATIBILITY ANALYSIS OF THE PROPOSED ACTION WITH RESPECT TO THESE PLANS

Examine and evaluate the plans for the proposed repository and discuss any impacts on existing land use plans. If adverse impacts on land use plans exist, describe the steps taken to mitigate those impacts. If adverse impacts can not be mitigated describe the plans and procedures for establishing agreements for modifying the existing land use plans. If no adverse impacts are apparent, a statement to this effect should be made and substantiated.

12.3 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

13.0 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Certain resources, as outlined in Chapter 11, are proposed to be committed to a terminal storage facility. Some of these resources are to be committed only for the short-term (i.e., for the period of the construction and operation of the facility); these commitments will only affect short-term uses. Other resources are committed for the long-term and will affect both alternative short-term uses and long-term productivity.

In this chapter alternative short-term uses and long-term productivity of the resources will be developed and compared with the proposed uses and productivity. This will include a brief summary of Chapters 10.0 and 11.0 with emphasis on major commitments.

13.1 ANTICIPATED USES AND PRODUCTIVITY WITHOUT FACILITY

13.1.1 Existing and Projected Short-Term Uses Including Land Use Plans

The expected short-term uses of each resource committed without the facility should be outlined and evaluated. This section should include pertinent outlines of existing land use plans.

13.1.1.1 Land

Present ownership of all land and land rights to be committed should be presented.

The estimated present value of the land should also be indicated (including land already government owned). Also the present worth of the rental value of the land during the proposed period of commitment should be indicated. The present uses of the land and if the uses are amenable to description in terms of annual dollar value of production then this measure of production should be presented. Otherwise a description of the value of the production (e.g., of ecological productivity) should be provided.

Projected uses (without the facility) during the period of time of construction and operation should also be presented. In the event that there are land use plans in existence, then these projections should be based on those plans. Otherwise projected uses will be based on best judgment.

13.1.1.2 Materials

The materials committed will have been outlined in Section 11.1. Reference to that listing should be made. The present worth of these materials should be estimated.

13.1.1.3 Manpower

Reference should be made to Section 3.4 and the present worth of the labor commitment should be estimated.

13.1.2 Projected Long-Term Productivity

Anticipated long-term productivities of each resource proposed to be committed for the long-term should be outlined and evaluated.

13.1.2.1 Land

Reference should be made to Section 11.1 and the present annual productivity of this land proposed to be permanently committed should be estimated.

13.1.2.2 Materials

Reference should be made to Section 11.1 for the amounts of materials permanently committed. The present value of these materials should be given and scarce or strategic materials should be indicated.

13.2 INCREMENT IN SHORT-TERM USES WITH FACILITY

In this section the present value of the projected short-term uses of land, materials, and manpower outlined in Section 11.1 should be presented. The present value of the repository should then be estimated. The difference in these values will be the increment (or decrement) in short-term uses with the facility.

13.3 DECREMENT IN LONG-TERM PRODUCTIVITY WITH FACILITY

This section will sum the value of resources proposed to be committed for the long-term as outlined in Section 11.1 and summarized in Section 13.2. These values represent the decrement in long-term productivity with the facility present.

13.4 SUMMARY OF CHANGES IN SHORT-TERM USES AND LONG-TERM PRODUCTIVITIES

This will be a summary of Sections 11.1, 13.1, and Chapter 10.0. It will emphasize major uses and productivities.

13.5 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

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14.0 ALTERNATIVES

In this chapter alternatives to terminal storage of radioactive materials in geologic formations will be presented. The range of alternatives considered must encompass the range of reasonable options. Each alternative which is introduced must be shown to be either less preferable or no more than equally preferable than the selected option.

The information relative to no action alternatives and other technology alternatives will come from published reports and national policy and planning documents. Information relative to the description, including quantitative estimates of inputs and outputs of other design alternatives will be obtained from the engineering designer. The description under other site alternatives will consist of a summary of the geologic and environmental regional, areal and locational surveys, the decision criteria and process which all led to the selection of the potential site. Information from the Generic Environmental Impact Statement for Commercial Waste Management will also be used as applicable.

14.1 PASSIVE (NO ACTION) ALTERNATIVES

The simplest connotation of "no action" is not a viable option, since high-level radioactive wastes from commercial operations do exist and more are being generated. "No action" is therefore used to refer to alternatives that would require neither the proposed facility nor the development of a new technology.

Each of these alternative actions should be briefly described in terms of the technical approach. The status should be assessed in terms of the probability and timing of its availability.

Environmental and dollar costs, resources committed and favorable effects of each alternative relative to the proposed action should be assessed. In each case the presentation should end with a conclusion that the alternative is better, worse or approximately equal to the proposed action in terms of all costs and commitments and in terms of availability within a required time period.

Typical "no action" alternatives to be considered shall include, but not necessarily be limited to:

14.1.1 Surface Storage

14.1.2 Use of Military Waste Storage Facilities

14.1.3 Use of Non-U.S. Storage Facilities

14.1.4 Retrievable Storage in Geologic Media

14.1.5 Postponement of Terminal Isolation Repository Facilities

14.2 ACTIVE ALTERNATIVES

The alternative actions considered in this section would require additional development. These alternative programs will therefore be presented in moreorless general terms depending on the state of development. As in the previous section, the technical approach, development status and timing of availability and costs relative to the proposed action should be assessed.

Use the following format to describe each of the active alternatives listed in this section.

- o Description of the Program
- o Comparison To the Proposed Program

14.2.1 Geologic Alternatives

14.2.1.1 Salt

14.2.1.2 Granite

14.2.1.3 Tuff

14.2.1.4 Shale

14.2.1.5 Polar Ice Cap

14.2.1.6 Seabed

14.2.2 Non-Geologic Alternatives

14.2.2.1 Transmutation

14.2.2.2 Surface Storage/Reprocess

14.2.2.3 Lagrangian Points

14.2.2.4 Lunar Impact

14.2.2.5 Solar Impact

14.3 DESIGN ALTERNATIVES

This section will present a comparison of alternate designs to the various systems and procedures for the proposed action. It is anticipated that this section would be developed by the engineering design groups and would consist of a summary of the engineering design efforts and decisionmaking. The format should be in terms of functional systems of the proposed repository. For each functional system reasonable alternatives should be briefly described and the logic for preference for the proposed system presented. Typical alternatives will include, for example:

- o Liquid effluent treatment systems
- o Gaseous emission treatment systems
- o Waste rock disposal and/or storage
- o Water makeup

14.4 SITE ALTERNATIVES

This section would present a summary of the site selection efforts and decisionmaking. This will consist of a description of the steps in the site selection process. These steps include the planning for the surveys, the results of the geologic and environmental surveys of the region, study area and location, the geologic and nongeologic criteria for the decisionmaking, key findings and/or decisions at each step in the siting process, and the actual decisionmaking process.

14.5 SUMMARY OF ALTERNATIVES

Summarize the conclusions reached in each of the previous sections describing various alternatives. Currently feasible alternatives should be presented in tabular form, listing the most feasible first.

14.6 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

15.0 SUMMARY COST-BENEFIT ANALYSIS

This chapter will present and compare the values of all of the unavoidable impacts, the favorable impacts, the resources committed, and the direct value of terminal storage. These values will be collated in terms of when and where they occur.

In this presentation, the values involved will also be sorted out in terms of whether they are values gained (i.e., benefits) values lost (i.e., costs) or values transferred from one place or people to another (i.e., economic transfers).

15.1 RELATIVE TO LOCAL CONSIDERATIONS

Major concerns in the consideration of local values - costs, benefits and economic transfers - are possible disparities between the elements of the society which suffer the costs and those which enjoy the benefits. Even the economic transfers may not accrue to those who are impacted negatively. ✓

Insofar as possible, such disparities should have been minimized within the process of developing the proposed action. Disparities which remain should be presented clearly; for example the people who may be displaced from their homes may not share any benefit from the payments for land. Taxes, or payments in lieu of taxes, may accrue to jurisdictions which are not primarily impacted. Efforts to mitigate impacts due to inadequate municipal facilities may not succeed in the time frame of significant impacts.

This section is a summary and should only present the major costs, benefits, and transfers. However, the word 'major' should be applied in the context of the affected party. In other words, a family dislocated from land on which several generations of that family have worked may suffer a major impact. Similarly, a small community can be greatly impacted by actions which, averaged over the nation are insignificant.

The presentation should, therefore, develop those elements (probably a list) of the local society and local ecosystems which will be affected and an accounting of the costs, benefits, and transfers accrued to or from each. The elements affected may include individuals, identifiable towns

or groups of people, political jurisdictions, and identifiable ecosystems. If there are significant disparities due to time frames (such as for successful implementation of measures) then a context of time should also be developed. This may be in terms of years or in terms of major program milestones. The presentation may take the form of a table of elements affected, time periods and the effects as costs, benefits, and economic transfers.

The impact of radiological doses to man due to normal and to accidental releases within the local context, should be discussed even though it may not constitute a significant impact in comparison to others. If, as expected, this impact is small then it should be explained that it is being addressed because of its importance in terms of popular concern rather than in terms of true cost. Provide the above information using the appropriate subsections below.

15.1.1 Benefits

15.1.2 Economic Transfers

15.1.3 Costs

15.1.4 Summary of Local Trade-Offs

15.2 RELATIVE TO NON-LOCAL CONSIDERATIONS

The national trade-off will be in terms of costs and benefits accrued to the nation. Economic transfers to or from the nation (for example payments for disposal of foreign wastes) should also be included.

The national trade-off of values will mainly involve the commitments of resources (i.e., land, materials, and manpower from Section 11.1) as compared to the national benefit.

It is expected that there will not be any unavoidable adverse effects of significance to the nation but, if there are any (such as reduced access to a national park) then they must be included. The radiological dose due to normal and to possible abnormal releases should be noted

whether or not it is important relative to other impacts; if its importance is minor then it should be explained that it is being included because of its popular concern.

The presentation of the national trade-off should be as simple as possible, perhaps by means of tabular listings.

15.2.1 Benefits

15.2.2 Economic Transfers

15.2.3 Costs

15.2.4 Summary of Non-Local Trade-Offs

15.3 RELATIVE TO LONG-TERM CONSIDERATIONS

The long-term will be construed as that period following decommissioning. Any significant long-term unavoidable adverse effects (from Section 10.4) should be noted. Long-term commitments of land and materials should be outlined (from Section 11.1). Long-term productivity which may be foreclosed should be summarized (from Chapter 13.0).

This section should first present a brief outline of long-term costs and benefits to establish a probable context of long-term values. The section should also include a brief resume of long-term radiologic impacts from improbable events. Provide the above information using the appropriate subsections below.

15.3.1 Benefits

15.3.2 Economic Transfers

15.3.3 Costs

15.3.4 Summary of Long-Term Trade-Offs

15.4 SUMMARY OF TRADE-OFFS

Use Sections 15.1.4, 15.2.4, and 15.3.4, to develop a table that compares the major trade-off values due to siting a repository in the proposed location.

15.5 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

16.0 ENVIRONMENTAL APPROVALS AND CONSULTATION

This chapter will include a list and the status of all licenses, permits, and other approvals for facility construction and operations to be obtained from Federal or other authorities for the protection of the environment. Additionally the requirements of state, local and/or regional authorities to be substantially satisfied by the facility should be identified.

The listing should cite the relevant statutory or other authority requiring approvals with respect to the construction and/or operation of the facility, and should be categorized by the environmental impact to which the approval is addressed. These categories could include, for example, radiological health, air, land, water use and planning, fish diversion, and construction effects.

16.1 FEDERAL, STATE, REGIONAL, AND LOCAL APPROVALS

The status of efforts to obtain a water quality certification under Section 401 and discharge permits under Section 402 of the Federal Water Pollution Control Act (FWPCA), as amended, should be discussed if applicable. If certification has not already been obtained, indicate when it is expected. If certification is not required, explain. Any other actions such as a pending request based on Section 316(b) of Public Law 92-500 (FWPCA) for alternative effluent limitations should be explained.

If a discharge could alter the quality of the water or air of another state, indicate the state or states that may be affected and their applicable limitations, standards, or regulations.

In view of the possible effects of the facility on the economic development of the region in which it is located, the applicant should also note the state, local, and regional planning authorities contacted or consulted. The Office of Management and Budget's Circular A-95 identifies the state, metropolitan, and regional clearinghouses that should be contacted as appropriate.

Where consumptive water uses involve permits or adjudication, evidence of such with respect to state, Federal, or compact or commission authorities having jurisdiction over the proposed diversion should be presented.

16.2 REFERENCES

This section should contain a listing of all references used in the preparation of this chapter. All references should be numbered in sequence of appearance in the chapter.

APPENDICES

GLOSSARY

ABBREVIATIONS AND ACRONYMS

BIBLIOGRAPHY

CALCULATIONS

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