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MEMORANDUM FOR: Those on attached list

FROM: William J. Dircks, Acting Director
Office of Nuclear Material Safety and Safeguards

SUBJECT: WASTE MANAGEMENT STAFF GUIDE "FORMAT AND CONTENT OF ENVIRONMENTAL REPORTS FOR CONVENTIONAL GEOLOGIC HIGH-LEVEL WASTE REPOSITORIES"

For the past several months, the High-Level and Transuranic Waste Branch of the U. S. Nuclear Regulatory Commission (NRC) has been developing a guide on the subject of the format and content of environmental reports for conventional geologic high-level waste repositories. The intent of this document is to provide the U. S. Department of Energy (DOE) with preliminary guidance in preparing environmental reports for high-level waste repositories.

Enclosed for your information is the first draft of this document. This guide represents the first attempt by the NRC to develop a position on the content and format of environmental reports for geologic repositories and, as such, will be modified in the near future as the NRC gains experience and expertise in performing environmental assessments of repositories.

If you or any member of your staff have questions concerning this draft guide, please call Regis R. Boyle (427-4433) of my staff.

William J. Dircks, Acting Director
Office of Nuclear Material Safety
and Safeguards

Enclosures:
1. Waste Management Staff Guide
2. Distribution List



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Waste Management Staff Guide

# FORMAT AND CONTENT OF ENVIRONMENTAL REPORTS FOR CONVENTIONAL GEOLOGIC HIGH-LEVEL WASTE REPOSITORIES

November 1978

High-Level and Transuranic Waste Branch

Office of Nuclear Material Safety and Safeguards

U.S. Nuclear Regulatory Commission

Washington, D.C.

# PREFACE

In the Energy Reorganization Act of 1974, Sections 202(3) and 202(4), the U.S. Nuclear Regulatory Commission (NRC) was granted regulatory authority over the receipt and storage of high-level radioactive wastes. In order to comply with this statute, the NRC is required to assess the potential environmental effects of any proposal to receive and store high-level radioactive wastes in a geologic repository prior to issuing a permit or license. The environmental assessment must comply with the National Environmental Policy Act (NEPA). In order to obtain information which is essential to this assessment, the NRC will require the applicant (the U.S. Department of Energy) for a permit or a license to submit a report on the potential environmental impacts of the proposed geologic repository and associated facilities.

The intent of this document is to identify the types of information and data needed by the NRC to perform an environmental assessment of any proposed geologic repository for the disposal of high-level wastes. This document represents the first draft by the NRC, and as such, the NRC expects to make many modifications in the future.

This document was prepared for making an environmental assessment of a conventional geologic repository. This should not be interpreted to imply that the NRC favors conventional geologic repositories over alternative disposal methods. However, based on current information before the NRC,[1] it appears that the first application to be received by the NRC from the Department of Energy (DOE) will be for a conventional geologic disposal facility. Thus, the NRC has prepared this document in anticipation of an application for the construction and operation of a geologic repository. The document should provide DOE and the public with the NRC staff's initial thoughts on the information and data needed to perform an environmental assessment.

Normally, the NRC provides guidance to prospective applicants after a considerable amount of experience has been gained in a particular field. However, in this instance, the NRC staff has no previous experience to fall back on other than that gained in carrying out environmental reviews of other nuclear facilities such as nuclear power plants and fuel cycle facilities. In developing the position set forth in this document, the NRC recognizes that the waste management program on a national basis is in a dynamic state. As this program evolves, modifications to this document will be required. Moreover, additions and deletions to the document will be made as the NRC gains experience and knowledge in dealing with geologic repositories.

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[1] The most current indications that geologic repositories are the preferred disposal method can be found in the "Report of Task Force for Review of Nuclear Waste Management," U.S. Department of Energy, February 1978, and the "Report to the President by the Interagency Review Group on Nuclear Waste Management," October 1978.

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# CHAPTER 1. PURPOSE AND NEED FOR THE PROPOSED REPOSITORY FACILITY

The purpose and need for the proposed facility should be presented in this Chapter. A summary description of the geologic repository should be presented to guide the development of later topics in the Environmental Report. Finally, the consequences associated with delaying the proposed facility should be set forth.

## 1.1 Purpose of the Proposed Facility

The purpose of the proposed facility with respect to the following objectives, as appropriate, should be addressed for the operational and isolation phases:

1. Types, forms, and sources of waste to be accepted and their relative amount with respect to the overall waste management program;

2. Extent to which the proposed facility will affect the overall existing and projected capacity requirement for waste facilities. Specifically, the rate and cumulative sum of wastes to be handled should be given in terms of canisters, curies, volume, mass, heat source, and other applicable units;

3. Whether the facility will be designed for temporary storage or permanent disposal of waste; and

4. Other objectives of the proposed facility.

## 1.2 Need for the Proposed Facility

The need for the proposed facility should be demonstrated in terms of the present and projected inventory of radioactive wastes from all sources and the desirability of their isolation from the biosphere. If the particular facility under review is also intended to demonstrate the feasibility of certain parts of the repository design or the overall feasibility of geologic disposal, this should also be discussed. Any experimental operations which will be carried out within the repository should be discussed in terms of the need for the information which these experiments will provide. Explicit definitions should be presented of those materials which will be considered radioactive waste and for any categories or subcategories such as "high-level," "intermediate-level," or "low-level," which are used in the Environmental Report.

## 1.3 Summary Description of the Proposed Project

A conceptual description should be presented of the proposed project which accommodates the needs and objectives specified in Sections 1.1 and 1.2. Detailed information will be presented in Chapter 4 but the initial description of general surface and subsurface designs and hydrogeologic environment should be presented in Chapter 1. The anticipated schedule for regulatory review, construction, operation, and isolation should also be presented.

## 1.4 Consequences of Delay

Consequences resulting from both short- and long-term delays in the completion of the proposed repository should be discussed. Impacts on the nation's energy and waste management program should be described for delays of different time duration.

# CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter should present the basis for the applicant's proposed choice of site and disposal technology among the various alternatives. Accordingly, the applicant should present the environmental impacts of the proposed action and all reasonable alternatives to that action in comparative form, thus providing a clear basis for selection among the options. A substantial and balanced treatment should be devoted to each alternative so that an evaluation can be made on the comparative merits of each alternative.

## 2.1 No Action Alternative

The applicant should consider the feasibility of taking no action on the proposed action in light of the need described in Chapter 1. Discuss the impacts and consequences of the no action alternative.

## 2.2 Interim Storage Alternatives

Describe the viability and environmental impacts associated with using interim storage techniques (e.g., away from reactor storage facilities (AFR)). Compare the environmental effects of these alternatives with those of the proposed action. Consider the benefits of using any of these storage techniques as an interim measure while potentially significant technological advancements might occur for alternative disposal methods.

## 2.3 Disposal Alternatives

The applicant should evaluate alternative methods for the long-term isolation of radioactive waste and compare these alternative methods with the proposed action. The methods of disposal which should be addressed include, but are not necessarily limited to, the following:

1. Partitioning and transmutation
2. Chemical resynthesis
3. Rock melting
4. Island
5. Sub-seabed
6. Tectonic plate
7. Ice sheet
8. Reverse well
9. Extraterrestrial or space

10. Very deep hole

2.3.1 Alternative Geologic Media/Site

This section of the environmental report should set forth the basis for the applicant's selection of geologic medium and site when compared to alternative geologic media and sites. The process or methodology along with any criteria which was employed by the applicant in selecting a geologic medium and site should be thoroughly and completely described. In describing this methodology, the applicant should provide the details of the winnowing process which lead to the selection of the proposed geologic medium and site. The applicant should identify viable alternative geologic media and sites and provide a balanced and detailed comparison between proposed medium and site and alternatives. For those alternatives which the applicant does not consider to be viable, an explanation should be given for this finding. All data used in the alternative media/site investigations should be documented.

2.3.1.1 Geologic Considerations. The applicant should present those geologic media which could provide the proper degree of isolation of radioactive waste from the biosphere. An analysis should be made which sets forth a point-by-point comparison of the characteristics which bear on the selection of the geologic medium. Some characteristics which should be addressed in this analysis are:

1. A lithologic/petrographic description of the repository media;

2. The potential for alteration or weathering of the media;

3. Thermal characteristics of the media:
   a. Specific heat
   b. Thermal conductivity
   c. Potential for changes in volume due to waste storage
   d. Potential for acceleration creep due to waste storage
   e. Potential for dehydration due to waste storage

4. Geochemical characteristics of the media;
   a. Ion exchange capacity
   b. Response to radiation
   c. Identification of chemical constituents which have potential for reacting with repository materials or products
   d. Other characteristics which may affect retardation

5. Mechanical and engineering properties of the media;
   a. Strength and deformation characteristics
   b. Structural characteristics such as cleavage, schistosity, foliation, bedding, and jointing

c. Moisture content
d. Potential for consolidation or compaction and swelling
e. Time dependent (creep) properties
f. Irradiation effects

6. Hydrologic properties of the repository media;
   a. Porosity
   b. Permeability or transmissivity
   c. Direction and magnitude of hydraulic gradients
   d. Presence of entrained water, groundwater, and aquifers and potential changes
   e. Bulk density
   f. Equilibrium distribution coefficients
   g. Dispersity
   h. Aquifer storage coefficient
   i. Compressibility
   j. Pore pressure

7. Depth and other dimensional requirements on the media; and

8. Required characteristics of overlying and underlying (surrounding) strata.

2.3.1.2 Overall Comparison of Alternative Geologic Media/Sites. An overall comparison in terms of both environmental and economic costs should be presented for the proposed geologic medium and site with the alternatives. The analysis should clearly set forth the justification for selecting the proposed medium/site combination over all other alternatives. In presenting the evaluation, the applicant should use, insofar as possible, a tabular format showing side-by-side comparisons of alternative with respect to selection criteria. The following list of factors is provided as a guide to the types of parameters that should be considered in an overall comparison of alternatives:

1. Engineering and environmental.
   a. Meteorology
   b. Climatology
   c. Geology
   d. Seismology
   e. Hydrology
   f. Demography
   g. Nearby industrial, transportation, and military activities
   h. Access to road, rail, and water transportation
   i. Suitability of transportation network for waste shipments
   j. Ecological sensitivity
   k. Commitment of resources and potential resources
   l. Aesthetics
   m. Socioeconomics

2. Land use.
   a. Dedicated areas
   b. Recreational usage

c. Agriculture
d. Industry
e. Land use planning

3. Water use.
   a. Water supply
   b. Water quality

4. Institutional.
   a. State restrictions
   b. Local/regional restrictions
   c. Federal restrictions

5. Construction.
   a. Equipment and materials handling
   b. Work force availability and accessibility
   c. Work force housing
   d. Mineability

6. Cost.
   a. Construction costs
   b. Operating and maintenance costs
   c. Land, water, and mineral rights
   d. Surface facilities
   e. Access roads and railroads
   f. Power and communication facilities
   g. Site preparation including technical investigations

Though quantification is desirable in the comparative analysis, it may not be possible for all factors because of lack of adequate data. Under such circumstances, qualitative and general comparative statements supported by documentation should be used.

# CHAPTER 3. THE SITE AND ENVIRONMENTAL INTERFACES

This chapter should present the basic relevant information concerning those physical, biological, and human characteristics of the area near the designated site that might be affected by the construction, operation, and isolation of a high-level waste repository. To the extent possible, the information presented should reflect observations and measurements made over a period of years.

## 3.1 Geography and Demography

### 3.1.1 Site Location and Description

3.1.1.1 Specification of Location. The site location should be specified by latitude and longitude of the main high-level waste shaft to the nearest second and by Universal Transverse Mercator Coordinates (Zone Number, Northing, and Easting, as found on USGS topographical maps) to the nearest 100 meters. The State and county or other political subdivision in which the site is located should be identified, as well as the location of the site with respect to prominent natural and man-made features such as rivers and lakes. A series of maps of successively larger scale should be presented to locate the site with respect to major political boundaries and natural features.

3.1.1.2 Site[1] Area. A map and aerial photograph of the site area of suitable scale (with explanatory text as necessary) should be included; it should clearly show the following, as applicable:

1. The facility property lines. The area (in hectares) within the facility property lines should be stated;

2. Location of the site boundary. If the site boundary lines are the same as the facility property lines, this should be stated;

3. The location and orientation of principal structures and access shafts within the site area. Principal structures should be identified as to function (e.g., warehouse, waste handling building, hoist house);

4. The location of any existing industrial, recreational, or residential structures within the site area;

5. The boundary lines of the area within which personnel access will be controlled;

[1] Site means the entire region, subterranean and surface, extending to the outer boundary of the buffer zone, which will be owned and controlled by the applicant for the purpose of high-level waste disposal.

6. The boundary lines of the area within which drilling, excavation, or mining activities will be controlled. If these boundary lines are the same as the facility property lines, this should be stated;

7. The boundaries of the horizontal extent of the subsurfaces facilities;

8. A scale that permits the measurement of distances with reasonable accuracy;

9. True north; and

10. Highways, railways, and waterways that traverse or are in the vicinity of the site.

3.1.1.3 Boundaries for Establishing Effluent Release Limits. The site description should define the boundary lines of the restricted area (as defined in 10 CFR Part 20, "Standards for Protection Against Radiation"). If it is proposed that limits higher than those established by K 20.106(a) (and related as to low as is reasonably achievable provisions) be set, the information required by K 20.106 should be submitted. The site map discussed above may be used to identify this area, or a separate map of this site may be used. Indicate the location of the boundary line with respect to the water's edge of nearby rivers and lakes. Distances from the facility effluent release points to the boundary line should be defined clearly.

3.1.2 Population Distribution

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

3.1.2.1 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-kilometer (10-mile) radius, concentric circles should be drawn, with the main high-level waste shaft at the center point, at distances of 2, 4, 6, 8, and 16 kilometers. The circles should be divided into 22-1/2 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 operation and (2) by census decade (e.g., 1990) through the projected operational phase of the repository. The tables should provide population totals for each sector and annular ring and a total for the 0 to 16 kilometer 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, J 18 years) for the year corresponding to the midpoint of the operational phase of the repository. The distribution by age of the U.S. population may be used

provided there is no knowledge the site has a significantly different distribution. Appendix A provides guidance concerning the use of the U.S. age population distribution.

Qualitative projections of long-term population changes should be attempted and the bases for these projections should be discussed.

3.1.2.2 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 kilometer intervals between the 16 and 80-kilometer radii from the main high-level waste shaft. 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 operational phase of the repository. The distribution by age of the U.S. population may be used provided there is no knowledge the site has a significantly different distribution. Appendix A provides guidance concerning the use of the U.S. age population distribution. Qualitative projections of long-term population changes and their bases should also be presented.

3.1.2.3 Transient Population. Seasonal and daily variations in population and population distribution within 16 kilometers of the proposed facility resulting from recreational or industrial land uses should be generally described and appropriately keyed to the areas and population numbers contained on the maps and tables of Sections 3.1.2.1 and 3.1.2.2. If the facility 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 populations. The additional tables should cover projected as well as current populations. Wherever possible, the expected residence times for the transient population should be given.

3.1.3 Uses of Adjacent Lands and Waters

On detailed topographical maps,[2] show the locations of the facility perimeter, controlled access area boundary, utility property, abutting and adjacent properties, water bodies, wooded areas, farms, residences, nearby settlements, commercial areas, industrial plants, parks, dedicated areas, other public facilities, valued areas (historic, scenic, cultural, recreational, or natural) and transportation links (railroads, highways, waterways). Specific attention should be given to uses which might indicate deep wells, mining activities or other subsurface uses.

[2]U.S. Geological Survey land use and land cover maps, in a scale of 1:100,000 or 1:250,000, or their equivalent, are preferred for this purpose. Also, if available, prime and unique farmland maps by the U.S. Department of Agriculture, Soil Conservation Service, and national wetland inventory maps (1:100,000 scale) by the U.S. Fish and Wildlife should be submitted.

Provide, in tabular form, the distances from the centerline of the main high-level waste shaft to the following for each of the 16 sectors described in Subsection 3.1.2 above:

1. Nearest residence (to a distance of 8 kilometers); and

2. Nearest site boundary.

Indicate (for the 8-kilometer-radius area) the nature and extent of present and projected land use (agriculture, livestock raising, dairies, pasturelands, residences, wildlife preserves, sanctuaries, hunting areas, extraction of natural resources, recreation, transportation, etc.) and any recent trends such as abnormal changes in population or industrial patterns. If the area near the plant site is zoned for specific uses, the applicant should indicate the zoning restrictions, both at the site and within 8 kilometers of the main high-level waste shaft location, and any local plans to restrict development to limit population encroachment.

Indicate the nature and amounts of present surface and groundwater use (water supplies, irrigation, reservoirs, recreation, transportation, etc.) within the site area. All locations of present and planned potential future water usage within 80 kilometers of the facility where the water supplies may be affected by groundwater or surface water transport from the site should be identified and the population associated with each use point given.

Data on both present and projected future water use should be summarized and tabulated; users should be located on maps of legible scale. Tabulations containing information similar to that listed below should be provided for water users that may be affected:

1. Number: Include numbers shown on maps identifying the location of water users;

2. Distance from Facility: Separate intake and discharge locations should be identified as follows:
   a. Identify radial distance from facility for each water user;
   b. Provide distance from facility via water route;

3. Coordinates: Provide map coordinates, if appropriate;

4. Withdrawal Rate: Provide present and projected withdrawal rate for each water use;

5. Return Rates: Provides present and projected return rates, if appropriate:

6. Type of Water Use: Provide type of water use of each location (e.g., municipal, industrial, irrigation); and

7. Source and Projection Dates of Water Use Estimates: Where use rates are anticipated to change over the life of the project, indicate periodic projections for the life of the project and the source of the projection information. Sources for such projections may be available for users or planning agencies at different levels of government.

If use varies seasonally by a significant amount, indicate monthly values for items 4 and 5 above. Also, where substantial holdup or flow changes occur in water use systems, such as in storage ponds or by flow augmentation, indicate the character of the changes.

In addition, for groundwater users, indicate the types of groundwater use, depth of wells, groundwater elevation, and return rates (if to surface water), and characterize the use by aquifer.

For the analysis and determination of site-specific exposure pathways, additional data and information may be required. Review the data requirements identified in NUREG-0158, "Draft Environmental Standard Review Plans for the Environmental Review of Construction Permit Applications for Nuclear Power Plants," Section 5.4.1, and provide the data, as appropriate.

## 3.2. Ecology

In this section, the applicant should describe the flora and fauna in the vicinity of the site, their habitats, and their distribution. This initial inventory will reveal certain organisms which, because of their importance to the community, should be given specific attention. A species is "important" (for the purposes of this guide) if a specific causal link can be identified between the repository facility 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,[3] (c) the species affects the well-being of some important species within criteria (a) or (b).

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 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 site area to the total regional area of the living resources (potential or exploited).

[3] In the development of environmental reports, specific consideration should be given to possible impact on any species (or its habitat) that has been determined to be endangered or threatened with endangerment by the Secretary of the Interior and the Secretary of Commerce. Terminology defining "endangered or threatened with endangerment" has been promulgated in Pub. Law 93-205, 87 Stat. 884. The applicant should consult the current Federal Register and State listings of threatened and endangered species, both floral and faunal, for comparison with the inventory of species found in the area.

The applicant should provide data on the count and distribution of important domestic fauna that may be involved in the radiological exposure of man. A map that shows the distribution of the principal communities should be provided.

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

Identify any definable preexisting environmental stresses from sources such as pollutants, as well as any 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 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.

Ambient noise levels should be reported for any sensitive locations within one kilometer of the proposed surface facilities. Examples of sensitive locations include breeding or nesting areas of important species, critical habitats of endangered species as specified by U.S. Department of Interior, and occupied dwellings. Sensitive locations such as hospitals or nursing homes which might be affected by excessive traffic noise (i.e., along major access corridors) during construction or operation should be identified with 80 kilometers of the site. Applicable local, State, and Federal noise regulations should be identified and provided.

## 3.3 Meteorology

This section should provide a meteorological description of the site and its surrounding area. Meteorological conditions that influence the design and operation of the facility must be identified. Sufficient information should be included to permit an independent evaluation by the NRC staff of atmospheric dispersion characteristics of the local area. The sources of information and data supplied should be stated and should include data collected from the onsite meteorological measurement program. In addition, the paleoclimatology should be analyzed in order to provide the basis for extrapolating future climate trends.

### 3.3.1 Regional Climatology

This section should describe the climate of the region pointing out characteristics attributable to the terrain. This should include an indication of monthly

and seasonal trends of meteorological conditions such as temperature, precipitation, and humidity. Data should be reported in sufficient detail to indicate impacts on facility design and long-term isolation of the waste.

3.3.1.1 Recent Climatology. The following information, concerning the recent climatology of the region in which the site is located, should be presented:

1. Monthly summaries of average, diurnal variations, and extremes of dry bulb temperature and atmospheric humidity (dew point or relative humidity). This should include information on severe cold and acute thaws;

2. Total precipitation (rain and snow) by month, number of hours with precipitation, and rainfall rate distributions;

3. Severe weather, including extreme winds, tornadoes, hurricanes, extreme precipitation (including snow, ice storms, etc.), hail, thunderstorms, and lighting; and

4. An estimate of the wind erosion index for determining the potential particulate emissions of contaminated soils.

All information should be fully documented and should be based upon data for the current "climatic normal" (i.e., recent 30-year) record period. Sources of such information could include the National Climatic Center, National Weather Service (NWS) stations, other government facilities (e.g., military stations), and private organizations such as universities that have maintained quality controlled data collection programs. The validity of the information provided, with respect to representativeness of conditions at and near the site during the expected period of operation of the facility, should be substantiated.

3.3.1.2 Long-Term Climatology. Consideration should also be given to potential climate changes (e.g., ice ages) and the effect on surface and subsurface hydrology. Based on reconstructions of past climates (since the beginning of the Pleistocene), long-term estimates of the following should be provided:

1. Maximum and minimum changes in precipitation and air temperature from the present that could be expected to occur in the future;

2. Regional precipitation patterns that may evolve in the future as a result of climatic and geologic changes;

3. Potential for glaciation, including estimates of times to onset of glaciation and length of glacial regimes, at the site; and

4. Estimates of future fluctuations in sea levels and cryosphere due to climatic changes that could affect the site hydrology.

A discussion should be provided of the impact of climatic change on precipitation patterns, local groundwater hydrology, erosion rates, and sea levels with

respect to the effects of such changes on local hydrologic flow pathways and aquifer recharge locations. Sources of data should be provided.

3.3.1.3 Design Basis Parameters. All meteorological parameters used as a design basis for any facility structures should be provided.

3.3.2 Dispersion Meteorology

Sufficient meteorological information should be provided to adequately characterize atmospheric dispersion processes (i.e., airflow trajectories, atmospheric stability conditions, depletion characteristics) out to a distance of 80 kilometers (50 miles) from the facility. The primary source of meteorological information could include available NWS stations, other meteorological programs with well maintained and exposed meteorological towers (e.g., other nuclear facilities, universities, private meteorological programs), and additional meteorological facilities established by the applicant (e.g., satellite towers) to characterize relevant dispersion conditions at important onsite and offsite locations.

Adequate characterization of atmospheric dispersion processes within 80 kilometers of the facility may include examination of meteorological data from stations at distances greater than 80 kilometers whenever this information can provide additional clarification of the mesoscale atmospheric dispersion process. All meteorological data should be concurrent for each station with the onsite data collection periods.

3.3.2.1 Topography. A map showing the detailed topographic features (as modified by the facility) on a large scale within an 8-kilometer (5-mile) radius of the site, a smaller scale map showing topography within an 80-kilometer (50-mile) radius of the facility, and a plot of maximum elevation versus distance from the center of the facility in each of the sixteen 22-1/2 degree compass point sectors (i.e., centered on true north, north-northeast, northeast, etc.) radiating from the facility to a distance of 80 kilometers should be provided.

3.3.2.2 Local Dispersion Meteorology. Monthly and annual joint frequency summaries of wind direction and speed by atmospheric stability class (as in Section 3.3.2.3), from onsite meteorological measurements and nearby representative stations, should be provided at all heights and intervals relevant to the atmospheric dispersion of airborne effluents released from the facility. This information should be based on at least one (and preferably two or more) annual cycle(s) of data from the onsite meteorological program. The data should be fully documented, and substantiated as to validity with regard to representing expected conditions at and near the site during the operational phase of the facility. Guidance on acceptable onsite meteorological measurements and a format for data presentation is presented in Regulatory Guide 1.23, "Onsite Meteorological Programs." If possible, hourly averages of wind speed and direction at all applicable heights and hourly averages of atmospheric stability should be presented as hour-by-hour data on magnetic tape. A recommended format for the presentation of hourly data on magnetic tape is provided in U.S. Nuclear Regulatory Commission Standard

Review Plan Section 2.3.3, Revision 1. A discussion of the impact of the local terrain and large bodies of water on meteorological conditions in the site vicinity, and the relationship of the data collected onsite to the meteorology of the region should be provided.

3.3.2.3 Regional Dispersion Meteorology. For an assessment of atmospheric dispersion to distances of 80 kilometers from the facility, the following additional regional meteorological information (based on at least a 1-year period of record) should be presented for as many relevant stations as practicable:

1. Wind speed and direction data at all heights at which wind characteristic data are applicable to the effluent releases from the facility;

2. Atmospheric stability as defined either by vertical temperature gradient or other well-documented parameters based on the results of diffusion experiments; and

3. Monthly mixing height data.

This information should be fully documented, and its validity, as being representative of expected conditions in the site region during the operational phase of the facility, should be substantiated.

3.3.2.4 Dispersion Evaluations. Detailed descriptions of the atmospheric dispersion models used to calculate relative atmospheric dispersion (X/Q) values for (1) continuous releases, (2) for releases which might occur over several hours, and (3) instantaneous releases of airborne radioactive material or other hazardous nonradioactive gaseous effluents should be provided for appropriate operational modes of the facility. A discussion of the accuracy and validity of the models, including the suitability of the input parameters, source configuration, and topography should also be provided. Meteorological data used as input to the models should be identified.

Short-term (accident) dispersion estimates should be provided for the site (or exclusion area) boundary and/or specific receptor locations for appropriate time periods after an accident based on onsite and local meteorological data. The conservatism of the models and the assumptions used in the models should be based on the severity of potential risks (consequence times probability) of the types of accidents analyzed.

Relative concentrations and relative deposition estimates for continuous and intermittent routine releases should be provided to a distance of 80 kilometers from the facility for appropriate distances and receptor locations using the models and assumptions described in Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors."

Unless it can be shown that the resuspension/deposition pathway of contaminated soil is not a critical pathway relative to the air pathway for offsite doses, a model for resuspension and deposition of soil particles should be

provided as an appendix, along with appropriate calculations for critical offsite locations.

## 3.4 Hydrology

The effects of facility construction, operation, and isolation on adjacent surface water and groundwater 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 groundwater bodies.

Information should be provided for those waters that may affect facility effluents and water supply or that may be reasonably assumed to be affected by the construction, operation, or isolation of the facility (including spoil piles). For those water bodies and systems that may receive radionuclides from the facility, detailed hydrologic descriptions of the site environment should be supplied out to a radius of 80 kilometers (50 miles) where hydrologically possible.

Expected seasonal and other temporal variations of important parameters (e.g., flow, currents, temperature, salinity, and sedimentation rates) 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 variation in release. Information relating to water quality characteristics should include measurements made on or in close proximity to the site.

Where a stream is to be used by the facility in any way, the estimated 7-day, once-in-10-years low flow and average flow conditions should be presented, in addition to observed instantaneous and average daily minimums. Furthermore, the period-of-record drought with the monthly flow sequence identified above, transposed to the intake and adjusted for existing and projected upstream developments, should be provided. A description of significant tributaries above and below the site, their monthly flow sequences (if necessary to identify future water use), and the pattern and gradients of drainage in the area should be provided.

For the groundwater environment, the hydrologic information should include descriptions of all the lithostratigraphic units in the area (including the units below the mining horizon), groundwater piezometric contour maps of preconstruction and projected postconstruction conditions, hydraulic gradients, permeabilities, total and effective porosities, bulk density estimates, storage coefficients, dispersion and distribution (sorption) coefficients, description of formations and soil types, including recharge zones, annual average recharge estimates, discharge areas, estimates of groundwater movement, average age

(retention time) of the groundwater and the distance to the nearest downgradient well or water body (note that geology is discussed in Section 3.5), chemical properties, and time histories of groundwater fluctuations. The applicant should provide data concerning any drawdown of groundwater 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.

Facility construction, operation, and isolation will affect the ground and surface water characteristics in the site area. Information should be provided to establish the bases for estimates of the effects. Where features of the proposed facility such as shafts, foundations, excavations, artificial lakes, and canals create artificial conduits for flow of groundwater between and among aquifers, the applicant should furnish sufficient site-specific detail to justify its evaluation of the effects of the facility on established groundwater tables and usage. (Note that water use at the site is discussed in Section 3.1.3.) Since failure of seals or linings spontaneously or due to subsidence of facility drifts, earthquakes, or man-made penetrations may occur, a description should be given of changes in water flows which might be caused by such events.

In addition to providing the information described above for the hydrologic environment in the immediate vicinity of the facility, information should also be provided for all points that could be affected by the facility within the 80-kilometer radius where water or a fluid is withdrawn or injected, or where 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 in the future. Chemical and biological parameters of the hydrologic environment should be described in a like manner.

## 3.5 Geology

A description of the major geological and seismological aspects of the site and its immediate environs should be provided. A discussion should be presented which assesses the degree of completeness and accuracy of the information available on the media and other important regional geologic features. Consideration should be given to the degree of investigation possible while still maintaining the integrity of the repository site.

In a geological assessment of a waste repository, the following specific topics relating to the repository media (and adjacent rocks, where appropriate) should be addressed:

1. A detailed lithologic/petrographic description of the repository media and overlying and underlying (surrounding) rocks which includes the mineralogy and rock fabric.

2. The three dimensional configuration of the media and surrounding rocks.

3. Zones of alteration or irregular weathering in the media and adjacent rocks

4. Geologic structure of the media and surrounding media to include the following:
   a. Fractures
      i. joints
      ii. faults
      iii. schistosity
   b. Folds
   c. Spacing and orientation of bedding planes, foliation, and joints
   d. Orientation of structures with respect to the modern stress regime and the potential for reactivation

5. Thermal characteristics of the media.
   a. Specific heat
   b. Thermal conductivity
   c. Potential for changes in volume due to waste storage
   d. Potential for accelerated creep due to waste storage
   e. Potential for dehydration due to waste storage

6. Mechanical and engineering properties of the media and adjacent rocks.
   a. Physical properties of intact rock determined by testing of core samples
      i. Strength of material including uniaxial tensile and compressive strength and triaxial compressive strength
      ii. Anisotropic strength characteristics due to cleavage, bedding, foliation, schistosity
      iii. Moisture content
      iv. Potential for swelling and slaking
      v. Time dependent (creep) properties
      vi. Deformation moduli
   b. Physical properties of the in situ rock mass
      i. Seismic wave propogation
      ii. Rock quality designation
      iii. Deformation moduli or the rock mass
      iv. Strength of rock mass
      v. In situ stresses
      vi. Time dependent (creep) properties

7. Geochemistry of the media.
   a. Ion exchange capacity
   b. Response to radiation
   c. Identification of chemical constituents which have potential for reacting with repository materials or products

8. Hydrologic properties of the repository media and adjacent rocks.
   a. Porosity
   b. Permeability
   c. Conductivity
   d. Groundwater characteristics (e.g., Eh, pH, DS)

9. Tectonics.
   a. Tectonic province and relation to surrounding provinces
   b. Geologic history and structural development of the region within 200 miles with emphasis on Cenozoic events and continuing deformational processes
   c. Structures which may control tectonic evolution
   d. Crustal stability (regional and site-specific)
   e. Regional stress regime
   f. Geothermometry
   g. Structures or trends revealed by remote sensing or geophysical methods

10. Seismicity.
   a. Historic seismicity in site area and surrounding region and its relationship to structure
   b. Seismic monitoring of site vicinity for definition of seismogenic structures
   c. Earthquake recurrence rates associated with the site area, with the region surrounding the site, and with structures in the site region or similar to those in the site region
   d. Maximum credible earthquakes in region and site area
      i. Structural association
      ii. Mechanism
   e. Seismic wave transmission characteristics of site and paths between source and site including potential for amplification and focusing
   f. Identification of potential causes and effects of induced seismicity
   g. Maximum vibratory ground motion anticipated at cavity level and specified depths within shafts

11. Geomorphology.
   a. Physiography
   b. Presently active geomorphic processes
      i. Weathering and erosion characteristics
      ii. Drainage characteristics
      iii. Rate (present and recent past) of denudation and slope retreat
   c. Potentially active geomorphic processes caused by climatic fluctuation, modified drainage or deleveling

12. Sealing characteristics.
   a. Techniques for locating penetrations of repository horizon
   b. Backfill materials and techniques
   c. Techniques for sealing penetrations and excavations

13. Natural resources.
   a. Resource potential
   b. Projected need for resources

## 3.6 Socioeconomics

This section should describe the following socioeconomic characteristics related to the repository site and regional vicinity:[4] (a) community characteristics, and (b) historic, archeological sites and natural landmarks.[5]

### 3.6.1 Community Characteristics

The following information concerning the region in which the repository is located should be presented:

1. Economic Base.
   a. Important regional industry by category, including employment and earnings;
   b. Major local and regional employers, including number of employees;
   c. Size and nature of the nearby construction industry and construction labor force within the region;
   d. Total regional labor force;
   e. Regional unemployment levels and future economic outlook; and
   f. Regional earnings and personal income.

2. Political Structure.
   a. Political jurisdictions and tax districts on the regional, county, and municipal levels, including any characteristics or interrelationships that are needed to understand potential impacts of repository construction, operation, and isolation; and
   b. Local and regional planning and administrative organizations.

3. Demography/Settlement Pattern.
   a. Population of the political jurisdictions identified above, including any unusual and relevant characteristics such as age patterns, or population densities; and
   b. Population forecasts as available by local, State, or Federal planners, university researchers, or others.

4. Social Structure.
   a. Major family and community structures (unique); and
   b. Integrative institutions such as important clubs, associations, etc.

5. Housing: Sales and rental market in region, number and types of units, turnover and vacancy rates, and trends in addition to housing stock, adequacy of structures, and location of existing and projected housing.

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[4]The region is defined herein as an area within an 80-kilometer radius of the facility.

[5]For additional information and guidance, NUREG-0158, "Draft Environmental Standard Review Plans for the Environmental Review of Construction Permit Applications for Nuclear Power Plants," sections 2.5.1, 2.5.2, and 2.5.3, should be reviewed for applicability.

6. Education: Regional primary and secondary schools and higher institutions, including capacity and present percentage of utilization.

7. Recreation: Public and private recreational facilities and opportunities, including present and projected capacity and percentage of utilization.

8. Taxation: Regional tax structure and distribution of the present revenues to each jurisdiction and district.

9. Land Use Planning and Zoning: Local plans concerning land use and zoning that are relevant to population growth, housing, and changes in land use patterns.

10. Social Services and Public Facilities.
    a. Present and projected water and sewer/sewage disposal facilities, including present capacity and projected percentage of utilization;
    b. Present and projected police and fire capabilities;
    c. Location of hospitals, number of medical doctors, and specialized health facilities, including present and projected capacities; and
    d. Welfare services and programs not covered under health services.

11. Highways and Transportation.
    a. Regional and local highway systems, including carrying capacity and condition of roads and highways;
    b. Availability and type of public transportation; and
    c. Modifications that might affect traffic flow to and from the repository site.

### 3.6.2 Historic and Archeological Sites and Natural Landmarks[6]

The following information concerning the vicinity in which the repository is located should be presented:

1. A detailed description of any archeological or historical surveys of the proposed repository site and associated service corridors including:
    a. The physical extent of the survey. If the entire site was not surveyed, the basis for selecting the area to be surveyed is needed;
    b. A brief description of the survey techniques used and the reason for the selection of the survey techniques used;
    c. The qualifications of the surveyors; and
    d. The findings of the survey in sufficient detail to permit the reviewer to make a subsequent assessment of the impact of the proposed repository on archeological and historic resources.

2. The comments of any organizations contacted by the applicant as part of the efforts to locate and assess archeological and historic resources located on or near the proposed repository site.

[6]Historic, archeological, and natural landmark resources include districts, sites, buildings, structures, or objects of historical, archeological, architectural, or cultural significance.

3. A description of all properties within 16 kilometers of the proposed repository site or within 2 kilometers of associated service corridors that are in or eligible for inclusion in the National Register of Historic Places and National Register of Natural Landmarks.

4. A description of any archeological or historic resources within 16 kilometers of the proposed repository site or within 2 kilometers of associated service corridors that are included in State or local registers or inventories of historic and cultural resources.

## 3.7 Radiological Characteristics

Describe the natural background radiation levels in the immediate vicinity of the respository site. The discussion should include the concentrations of radioactive materials found in important biota, soil, geological formations, regional surface water, and local groundwater as established by the pre-operational radiological monitoring program.

## 3.8 Environmental Measurement Programs

The programs for collection of the initial or baseline environmental data should be designated in sufficient detail to make it clear that the applicant has established a thorough and comprehensive approach to environmental assessment. The purpose of these programs is to establish a reference framework for assessing subsequent environmental effects attributable to the construction, operational, and isolation phases of the repository facility. While the staff can not change these programs at the time of license application, it is still useful to the reviewer to have detailed information available which describes how the information presented in this chapter was obtained.

The description of these programs should be confined principally to technical descriptions of technique, instrumentation, scheduling, and procedures. Detailed portions may be provided in appendices in order to allow a clear and precise presentation of the results in the main body of the report. Quantitative descriptions of samples should include, where applicable, standard estimates of value, probable error and variability, e.g., mean, standard deviation, standard error, and a confidence interval for the mean.

The onsite meteorological measurement program conducted to develop local data and programs for use during facility operation to estimate offsite concentrations of released effluents should be described. Include measurements made, locations and elevations of measurements, description of instruments used, instrument performance specifications, calibration and maintenance procedures, and data analysis procedures.

# CHAPTER 4. THE REPOSITORY FACILITY

The repository facility design features should be described in this chapter. Since environmental effects are of primary concern in the ER, the repository effluents and facility-related systems that interact with the environment should be described in particular detail, as well as the technical bases for all design parameters which appear to be important in affecting potential accident considerations.

## 4.1 Definition of Wastes and Acceptability Criteria for Waste Forms and Packages

Identify the waste classes for which the repository is seeking license. Estimate quantities of the various waste forms to be received over the operational phase of the repository and the capacity of the repository to receive the various wastes per unit of time (i.e., day, month, year) and over its lifetime. The information provided should include: the criticality potential and provisions for preventing criticality occurrences, the waste cooling provisions, records inventory, monitoring features, organic content of waste, number of containers, curies, heat load, receipt rate vs. time, external contamination that can be handled, etc. Delineate what tests will be performed at the repository site to confirm waste acceptability. Describe any potential environmental impact of the acceptance tests. Describe the waste containers that will be handled at the repository (e.g., canisters, casks, overpacks).

## 4.2 Facility Description

### 4.2.1 Surface Support Facilities and Interim Storage Facilities

The layout of the surface facilities and the surface site perimeter should be illustrated and related to the site maps in Section 3.1. The profile of the surface facilities should be shown to scale by line drawings or other illustrative techniques. Provide an architectural rendition of the proposed project. A recent oblique aerial photograph of the proposed surface facility location and an aerial photograph of the site on which major project features are superimposed should be included. Indicate the total area owned by the applicant and that part occupied or modified by the repository facilities. Indicate other existing and projected uses, if any, of the applicant's property and the area devoted to these uses. Describe any plans for site modifications, such as a visitors' center or park.

A functional description of each of the facilities' structures should be included, highlighting location and elevation of exterior material transfer ports (e.g., intake and output vents for the ventilation systems, building doors or other openings for transfer of canisters, casks, railroad cars, trucks, supplies, and nonradioactive as well as radioactive onsite generated solid, liquid and gaseous waste) to or between buildings. A system of coordinates (x,y) should allow clear location of all material entrances and exits. Presence or absence of interim storage facilities at the repository site should be explicitly noted since such facilities have considerable impact in defining the functions of the repository surface facilities.

The applicant should describe efforts made in locating facilities on the site to use existing terrain and vegetation to achieve seclusion and sight screening as appropriate to the topography. In addition, the architectural design efforts made to integrate the facilities into their environmental setting and to create aesthetically pleasing buildings and grounds should be noted. Where there are National Register properties in the site vicinity, provide one or more ground-level photographs of the site taken from these properties, on which major facility features are superimposed. These photographs should be representative of potential visual impacts. Discuss the efforts made in the layout of the site perimeter and surface facilities to provide necessary site security measures.

### 4.2.2 Subsurface Facilities

Provide perspective, areal and general layout drawings of the planned underground facility. Describe the functions of the various parts of the facility, for example, the different purposes of separate shafts, reasons for the tunnel or chamber geometry chosen, advantages of the chosen mining depths, expected mining and back-filling sequences, expected machinery to be used, structure maintenance, and connection of subsurface facilities to surface facilities.

In addition to information similar to that provided on surface facilities, construction materials and techniques to be used in lining and sealing shafts should be described in terms of the degree and duration of isolation they are expected to provide, particularly from intrusion by water and/or other liquids. Backfill materials and techniques to be used in the repository should be described and discussed. Describe the monitoring and data acquisition systems which will be used to determine properties of the media after high-level waste emplacement and for a finite time after backfill. The codes and analytical models used in the design of the facility should be presented and the source of site-specific data used as input for the codes should be given as appendices.

Special design provisions for handling I-129, Kr-85, and TRU from Uranium Fuel Cycle Facilities (40 CFR Part 190) should be described, as applicable. Special provisions for coping with intrusion by water, other liquids, and man prior to backfill and post-backfill should be described. The potential for steam and pressure formation in the facility and the complications or impact of these on high-level waste isolation should be addressed.

### 4.2.3. Auxiliary and Transportation Systems

4.2.3.1 Water. Water supply systems for normal operation should be discussed in detail. Process flow diagrams and scale drawings of water lines and any discharge structures should be presented. The water bodies or sources from which the water is withdrawn and discharged should be identified. Present a quantitative water-use diagram for the repository facility showing anticipated maximum and monthly average flow rates and pumping requirements to and from the various water systems (e.g., sanitary system, solar heaters, radwaste and

chemical waste systems). The source of the water for each input should be described. The anticipated maximum and monthly average consumptive use of water should be shown. The above data that quantify facility water use should be tabulated for various facility conditions, including maximum facility operation and temporary shutdown. Describe any onsite storage pools or reservoirs.

If the applicant is responsible for building water lines to the repository site, the following information should be provided. Sufficient information should be provided on external appearance of water lines to permit an assessment of their aesthetic impact. Indicate the dimensions, materials, color, and finish of water line structures and related facilities. The lengths, widths, and acreage of the proposed rights-of-way should be specified. The applicant should characterize the land types to be crossed by water lines and indicate the present and expected usage of such land. Any area where construction of the water lines will require permanent clearing of trees and vegetation, changes in topography, or removal of man-made structures should also be indicated, as well as areas where the water lines will be placed underground. Indicate where highways, railways, water bodies, and areas of archeological, historic, and recreational interest will be crossed.

4.2.3.2 Power and Communications. If the applicant is responsible for constructing transmission or telephone lines and/or substations to or from the site, then reference should be made to Regulatory Guide 4.2, Section 3.9, for guidance.

4.2.3.3 Transportation. Describe the types of transportation systems that will serve the repository. Identify the need for constructing any new access roads, railroad spurs, or other transportation systems. Indicate if any transportation systems will be upgraded. Present the specific locations of all transportation systems and details of the designs.

## 4.3 Radioactive Waste Processing Systems

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 facility during normal operation including anticipated operational occurrences (e.g., purging, equipment downtime, maintenance).

### 4.3.1 Source Terms

Provide the sources of radioactivity that serve as input to the liquid, gaseous, and solid radioactive waste treatment systems for normal operation and anticipated operational occurrences.

For purposes of evaluating the effluents from the various ventilation systems, provide estimates of the leakage rates from storage casks, spent fuel, cannisters, and other fluid systems containing radioactivity into buildings

and areas serviced by the ventilation systems. Identify planned operations and anticipated operational occurrences that may result in the release of radioactive materials to the environment. Consider leakage rates and concentrations of radioactive materials for both expected and design conditions. Tabulate the sources of leakage and estimate their contribution to the total quantity. Describe special design features provided to reduce leakage. Provide estimates of the releases of radioactive gases, radioactive particulates, and radioiodines (by radionuclide) from each leakage source, and describe their subsequent transport mechanisms and release paths. Provide the bases for the values used. Cite previous pertinent experience from operating facilities, describing any changes from previous designs that would affect the release of radioactive materials to the environment.

4.3.2 Liquid Waste Processing Systems

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 piping and instrumentation diagrams and flow diagrams for the liquid radwaste systems. 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. Estimate the fraction of each processing stream expected to be discharged during the operational phase of the facility.

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).

4.3.3 Gaseous Waste Processing Systems

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 those systems designed to process gases used to cool high-level waste casks and building ventilation systems that exhaust potentially radioactive materials from surface and subsurface structures to the enviroment. Indicate systems that incorporate high-efficiency particulate air (HEPA) filters and/or charcoal adsorbers in the treatment of building effluents. Estimate component decontamination factors and their bases (include charcoal adsorbers, HEPA filters, mechanical devices). Provide piping and instrumentation diagrams and flow diagrams for all gaseous radwaste systems. 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. Estimated quantities should be given in terms of cubic meters, total curie content, and activity concentration in uCi/cc.

Indicate which systems are used continuously and which are operated only under specific circumstances. Indicate the expected system purge and venting frequencies and duration, and continuous purge rate (if used). Note those systems that are shared between separate structures and also those that share a common effluent release point. Identify all gaseous radioactive effluent release points including heights above facility 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).

### 4.3.4 Solid Waste Processing Systems

Describe the solid radwaste system and its capability to solidify liquid waste concentrates and to handle, store, and package for disposal 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 meters of solid product (as processed and prepared for shipment), total curie content, and activity concentration in curies per package, or curies per cubic meter.

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

Provide piping and instrumentation diagrams and flow diagrams showing the origin, treatment, storage, and disposal provisions for all solid radwaste generated by the facility under consideration. Show system and component capacities, and identify the normal mode of operation.

In the event that the solid wastes are not disposed of onsite, provide a description of the packaging system prior to shipment. Also, estimate the decay time provided in storage prior shipment offsite.

### 4.3.5 Process and Effluent Monitoring

Identify all radioactive effluent release points, and indicate which points are continuously monitored. Note those monitors that automatically terminate effluent discharges upon alarm. Indicate those monitors that, upon alarm, automatically actuate standby or alternative treatment systems or that automatically divert streams to holdup tanks.

## 4.4 Nonradioactive Waste Processing Systems

### 4.4.1 Chemical Waste Systems

The applicant should provide a complete list of all chemicals to be used at the proposed facility. Chemical names and formulae should be given in addition

to generic or trade names wherever possible. The list should describe in tabular form the use of each chemical agent, the frequency of use, and the average and maximum quantities used annually.

Identify all liquid, gaseous, and solid sources of chemical waste generated at the facility, e.g., laboratory waste, area rainfall runoff from construction activities, materials storage piles, and spoil piles; waste streams or discharges from roof, yard, and other drains; and other waste streams that may enter the local environment as a result of facility construction and operation.

The expected average and maximum design discharge concentrations of each chemical for each permitted facility discharge should be listed in a table along with the chemical concentrations in each of the above-mentioned waste source categories. Each chemical should be compared with applicable local, State, and Federal effluent limitations and guidelines and reported in the table. All flow rates and frequencies of discharge for the waste sources should also be included in the table. The manner in which they will be treated and controlled should also be described.

### 4.4.2 Other Waste Systems

The applicant should describe any other nonradioactive solid or liquid waste materials such as sanitary waste that may be generated during facility construction and operation. The description should include estimates of the quantities of wastes to be disposed of, their concentration, their biochemical oxygen demands at points of release, as appropriate to the system, and other relevant data. The manner in which they will be treated and controlled and the procedures for disposal should also be described. Means for control and treatment of all systems subject to applicable local, State, and Federal effluent limitations and guidelines should be described.

The applicant should (a) describe any nonradioactive gaseous effluents (e.g., from diesel engines, gas turbines, heating plants, incinerators) discharged during facility operation, (b) estimate the frequency of releases and describe how the effluents will be treated before release to the environment, (c) estimate the total quantity of $SO_2$, $NO_x$, CO, hydrocarbons, and particulates to be discharged annually, and (d) compare the releases to the applicabe local, State, and Federal limitations and guidelines for air quality.

## 4.5 Experimental Program Plans

Identify and describe any experiments involving radioactive material. State which experiments will be conducted under laboratory conditions in the surface facilities and which under environmental conditions in the subsurface facilities. Characterize the pollutants generated by laboratory and in situ experiments, and delineate how they enter the radwaste systems described in Section 4.3.

## 4.6 Waste Retrieval

It is anticipated that the repository is either designed for retrievability for a given period of time or is designed from the outset for disposal. If the repository is designed for retrievability, describe the design features, operating procedures, and equipment that would allow waste retrieval until the repository is sealed. If the repository is not designed for waste retrievability, describe the contingency plans for waste retrieval for an unplanned occurrence such as discovery of geologic instabilities, or a change in national waste disposal policy. Discuss the relative capability of retrieval as a function of time during the operational phase of the repository considering canister and waste form integrity. Describe the planned disposition of the wastes should retrieval become necessary.

# CHAPTER 5. ENVIRONMENTAL EFFECTS OF THE FACILITY CONSTRUCTION PHASE

This chapter of the applicant's environmental report should discuss the expected effects of site preparation and facility construction. The effects should be presented in terms of their physical impact on the resources and populations described in Chapter 3. Means selected by the applicant to measure, minimize, and/or mitigate related detrimental environmental effects should be outlined.

In the applicant's discussion of adverse environmental effects, it should be made clear which of these are considered unavoidable and subject to later amelioration and which are irreversible. Those effects that represent an irretrievable commitment of resources should receive detailed consideration in Section 5.4. (In the context of this discussion, "irretrievable commitment of resources" alludes to natural resources and means a permanent impairment of these, e.g., preclusion of future land use, consumption of mineral or fossil fuel resources; loss of wildlife habitat; destruction of nesting, breeding, or nursing areas; loss of valuable or aesthetically treasured natural areas as well as expenditure of directly utilized resources.)

## 5.1 Land Use Impacts

The applicant should show in tabular form the land area requirements affected by the facility and related service corridors. Where applicable, areas should be specified for the site, surface facilities, and access corridors. The area of the surface facilities and the estimated grading and excavation requirements should also be specified. Indicate the amount of land which will be returned to previous use at the end of the construction period. Describe how the construction activities may disturb existing terrain and wildlife habitats.

Discuss the site preparation and construction impacts on the land use functions described in Section 3.1.3. Identify efforts to minimize or mitigate impacts resulting from dust, noise, erosion, and other pollutants. Explore the impact of construction on unique geological, paleontological, or mineralogical features on the site or in the immediate vicinity. Discuss the expected impacts on historical, cultural, recreational, and archeological sites and natural landmarks in the region.[1]

The planned operation of a repository depends on the integrity of the subsurface geological formations which will be expected to contain the waste. The

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[1] Depending on location, the construction of a waste repository and associated access roads, landscaping, etc., may have an impact on monuments of the National Geodetic Control Networks. The applicant should list all known markers in the construction area in its review and independently notify the National Oceanic and Atmospheric Administration, National Geodetic Survey (NGS) of any impending damage to markers so that efforts can be made to relocate them prior to destruction.

effects of exploration (drilling), excavation (including blasting), and other phases of the construction program on the physical properties and integrity of the media at or near the facility should be discussed. The effects of construction activities on surface or near surface geographic features should be presented.

## 5.2 Water Use Impacts

Describe the impact of site preparation and construction activities on the water related uses identified in Section 3.1.3. The overall plan for protection of water bodies (e.g., recreation, reservoir) that may be affected by facility construction should be discussed. Activities that might affect water use include the construction of cofferdams, roads, bridges, and storm sewers, dredging operations, dewatering, and placement of fill material in the water. The applicant should describe the effects of these activities on other surface and groundwater users.

## 5.3 Nonradiological Waste Impacts

Discuss the different types and quantities of solid waste generated during site preparation and facility construction. These wastes would include clearing and demolition/construction waste, domestic (municipal-type) solid waste, spoil from mining activities, and nonradiological hazardous waste. Describe the methods and practices utilized for collection, storage, and disposal of these wastes to assure compliance with applicable local, State, and Federal solid waste management regulations.

## 5.4 Resources Committed

The absolute and relative nature of any irreversible and irretrievable commitment of resources due to site preparation or facility construction should be evaluated. The evaluation should include direct resource commitments (e.g., land, mineral, labor, and material resources) and environmental resources commitments (e.g., wildlife habitats, and natural, scenic, and cultural resources). The relative nature of this evaluation should be completed in terms of percentages which relate the amount of an expected resource loss to the total resource in the immediate region and in the surrounding regions. If economic values can be established for these committed resources, provide such an estimate.

## 5.5 Socioeconomic Impacts[2]

### 5.5.1 Historic and Archeological Sites and Natural Landmarks

This section should be planned to accomplish the following objectives: (1) a comprehensive disclosure of impacts; (2) presentation of the basis used for the analysis; and (3) presentation of conclusions regarding impacts of

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[2]For additional information and guidance, NUREG-0158, "Draft Environmental Standard Review Plans for the Environmental Review of Construction Permit Applications for Nuclear Power Plants," Sections 4.1.3, 4.4.1, 4.4.2, and 4.6 should be reviewed for applicability.

construction activities on historic and cultural resources. The following specific information should be included:

1. For properties in or eligible for inclusion in the National Register that will not be affected, provide a positive statement of no effect.[3]

2. Describe significant impacts to those properties that are in or eligible for inclusion in the National Register. Discuss the steps which led to a determination of whether or not any effects are adverse.[3]

3. Describe the significant impacts on cultural and historic resources not eligible for inclusion in the National Register.

4. Describe any alternatives considered and the reasons for their acceptance or rejection.

5.5.2 Social and Economic

This section should provide a statement of the scope of coverage and the objective of the analysis; a summary of the steps taken in the analysis and references to methodologies employed; a summary of the findings of the analysis for each impact category; and an identification and assessment of potential mitigation measures. Impacts should be categorized as those resulting from repository construction and those resulting from the activities of the construction labor force.

5.5.2.1 Repository Construction. This section should provide the following determinations:

1. The annual value of the major categories of materials, equipment, and services to be purchased within the region and compare that value to the value of such categories that would have been produced without repository construction;

2. The annual construction labor force requirements (for each quarter year, if possible) over the construction period and compare to the number of workers available from within the region; where necessary, determine these requirements for the major construction crafts, using standard craft categories;

3. Construction labor wage rates and payrolls and compare the wage rates with industries from which labor might be drawn.

4. By jursdiction, tax revenues derived from repository construction, purchased services, materials and equipment;

5. The physical demands placed by repository construction on local public facilities and services (e.g., fire, police, sewer, and water) and compare these demands with existing facilities and services;

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[3] See Appendix A to Section 2.5.3 of NUREG-0158.

6. If any impacts identified under land use, water use, and ecological impacts require additional analysis regarding social and economic consequences; and

7. The number of people to be displaced by repository construction.

5.5.2.2 Construction Labor Force. This section should provide the following information:

1. From the previous estimates of construction labor requirements and the number of workers available within the region, predict the number of workers originating from within the region and the number of in-movers.

2. Determine the family characteristics of construction force in-movers. Predict their temporal and geographic distribution.

3. Determine number and family characteristics of induced in-movers and predict their temporal and geographic distribution.

4. Determine the overall impact of in-movers on regional income, employment, and population. Identify critical services and goods for the affected region.

5. Predict potential changes in regional housing patterns (e.g., availability, type of construction, densities, distribution, and value).

6. Determine the level of public facilities and services required to support in-movers as a function of their probable location. Identify problems that local government may have in meeting these demands. Types of facilities and services that should be considered include education, water and sewer, safety, health, welfare, transportation, and recreation.

7. Identify adverse traffic conditions caused by transportation of workers and materials to and from the site.

8. Determine by jurisdiction the flow of tax revenues generated by the construction payroll and induced economic activity.

9. Compare the total flow of tax revenues from the various sources associated with repository construction to the expenditures required to meet the additional demand for public facilities and services.

10. Identify noteworthy changes that might occur in the social and political structure and character of impacted communities. Identify major differential impacts on various social groups such as economic, occupational, or age groups.

11. Describe the mechanisms available to potentially impacted localities to plan for and accommodate changes induced by repository construction.

## 5.6 Construction Impact Control Program[4]

The construction authorization 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 proposed measures and procedures designed to mitigate or reverse the undesirable effects on environmental quality previously identified in this chapter.

Additionally, provide a statement of the commitment to limit or control potential socioeconomic impacts. Specific information should include: (1) identification of the impact to be mitigated; (2) a monitoring and planned control program relating to the impacts; and (3) procedures which will be employed in controlling the impacts.

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[4] A compilation of construction practices is provided in General Environmental Guidelines for Evaluating and Reporting the Effects of Nuclear Power Plant Site Preparation, Plant and Transmission Facilities Construction, AIF/NESP-003, February 1974. This document may provide appropriate information and guidance on the establishment of a program. Copies may be obtained from the Atomic Industrial Forum, Inc., 7107 Wisconsin Avenue, Washington, D.C. 20014.

# CHAPTER 6. ENVIRONMENTAL EFFECTS OF REPOSITORY OPERATIONAL PHASE

This chapter should describe the interaction of the repository and the environment. Measures planned to reduce any undesirable effects of repository operation on the environment should be described in detail. In the discussion of environmental effects of the operational phase, as in Chapter 5, effects that are considered unavoidable but either inherently temporary or subject to later amelioration should be clearly distinguished from those regarded as irreversible. Those effects that represent an irretrievable commitment of resources should receive detailed consideration in Section 6.7.

The impacts of operation of the proposed facility should be, to the fullest extent practicable, quantified and systematically presented. In the discussion of each impact, the applicant should make clear whether the supporting evidence is based on theoretical, laboratory, onsite, or field studies undertaken on this or on previous occasions. The source of each impact and the population or resource affected should be clearly identified in each case. The impacts should be distinguished in terms of their effects on surface water bodies, groundwater, air, and land.

## 6.1 Land Use Impacts

The applicant should indicate the amount of land that the facility and related service corridors will occupy during the operational phase. Identify the impacts on flora and fauna in the vicinity of the site, their habitats, and their distribution. Indicate the preclusion of land use (agriculture, livestock raising, dairies, pastureland, residences, wildlife preserves, sanctuaries, hunting areas, extraction of natural resources, recreation, transportation, etc.) that results from the facility's operation. Assess the probable impacts of the respository operational phase on land use of adjacent areas to establish if any would be severe enough to result in a change of land use patterns in the site vicinity. Discuss the expected impacts on historical, cultural, and archeological sites and natural landmarks in the region.

## 6.2 Water Use Impacts

Describe the impact of facility operation on the water-related uses identified in Section 3.1.3. The overall plan for protection of water bodies (e.g., recreation, reservior) that may be affected by operation should be discussed. Indicate the estimated amount of water use and the source of the water supply for the facility. Discuss the impact of this water use on the available water supplies in the area. Describe anticipated changes on regional water (e.g., lakes, streams, groundwater) as a result of facility operation. Categorize these changes as physical, chemical, and thermal. Discuss the impacts of water use on ecosystems in the vicinity of the site.

## 6.3 Nonradiological Waste Impacts

The environmental effects of nonradiological waste discharges from the systems described in Chapter 4 should be evaluated. These evaluations must be made within the framework of applicable local, State, and Federal regulations and guidelines, and provide reasonable predictions of the kind, amount, and distribution of projected nonradiological waste effluent discharges.

The applicant should outline the sources, quantities, composition (including chemical and physical properties), and frequency of waste discharges from operation of the facility to the water, land, and air. Particular emphasis should be given to the ambient concentration and toxicity of chemicals contained in these discharges. Examples of sources include sanitary and chemical contamination in domestic water supplies (from surface water bodies or groundwater), standby diesel generator emissions, and spoil piles created from mining operations and maintained for future use in sealing of the depository.

Identify and quantify the impacts to the ecosystems, including humans, resulting from the nonradiological waste discharges. Appropriate references to the baseline data contained in Chapter 3 should be made. Discuss the measures and controls planned to limit the adverse impacts identified.

Indicate the applicable local, State, and Federal regulations and guidelines and the extent of compliance for liquid discharges, solid waste disposal, and air quality (e.g., Federal Water Pollution Control Act, Solid Waste Disposal Act, Federal Clean Air Act).

## 6.4 Effects on Geologic Environment

The excavation of subsurface cavities can affect the local geologic formations through subsidence, fracturing, reorientation of stress, etc. The high-level waste, as a source of heat, radiation, or chemicals, may affect the confining geologic formations or groundwater flow. This section should present the possible effects of the waste or excavations on both the surface and subsurface environments. Any surface or subsurface effects due to dissipation of the heat load should also be discussed. Topics which should be covered in such a discussion include:

1. Thermal effects of the waste on the adjacent rock of the storage facility with respect to:

    a. Temperature changes (steady state equilibrium condition, gradients, potential for transients, effects of peak transients)
    b. Changes in volume
    c. Accelerated creep
    d. Fracturing
    e. Groundwater movement
    f. Hydration/dehydration
    g. Potential mass flow caused by buoyancy and gravitational instability

h. Thermal conductivity
i. Specific heat
j. Thermal expansion coefficient
k. Gas explosion potential
l. Moduli

2. Thermal effects at the ground surface.

3. Mechanical effects of the repository with respect to:

   a. Reorientation and any other changes in the local st te of stress, stress relief
   b. Changes in material or backfill densities, moduli
   c. Subsidence
   d. Fracturing
   e. Induced Seismicity

4. Chemical effects of waste on the adjacent rock considering possible contributions from waste packaging material and any gas or liquid which may be generated.

5. Effects of radiation on the adjacent rock such as:

   a. Stored energy
   b. Radiolysis
   c. Creep properties

6. Modification of the Hydrologic Regime.

## 6.5 Radiological Effects

Routine and nonroutine releases to the environment may result in exposure of the general public to increased radiation levels over short or very long time periods. In discussing the radiological effects of operation of the repository, the applicant should estimate the short and long-term exposure of the public. Efforts to maintain all exposures as low as reasonably achievable should be described in the context of establishing the dose estimates.

Routine radiological effluent releases should be identified and quantified and their release points indicated. Nonroutine releases which can be expected as a result of onsite handling or transportation should be described. If ranges are appropriate they should be estimated. Fractional releases due to failure of cooling for canisters in temporary storage should be determined and presented as a function of temperature or other critical parameter. Any other potential causes of radiological effluents such as abnormal operating conditions in the repository or physical-chemical changes in the waste form should be discussed and the potential releases should be described.

The local dispersion characteristics and the population information in Chapter 3 should be used in conjunction with the information of routine and

nonroutine releases to estimate doses to individuals and to the population within 80 kilometers of the facility. The dose estimates may require consideration of exposure models contained in Regulatory Guides 1.109, 1.111, 1.112, and 1.113.[1] Estimates of contamination levels are generally determined pursuant to the dose estimates. The contamination levels and this potential for continued exposures of the population should be discussed. Calculational models and techniques should be discussed in detail with reference to appropriate documentation of their development and verification.

Potential biological effects should be estimated and presented based on exposures. The models used to obtain the estimates should also be presented. Ranges of uncertainty and the factors influencing the uncertainty in consequences should be discussed.

## 6.6 Transportation

Describe the transportation system which will bring wastes to the repository. Specify the modes of transportation (e.g., truck, rail, barge) to be used. Describe the vehicles involved (e.g., dimensions, weight, design). Describe the waste packaging design and performance standards providing container drawings and specifications for external radiation levels and package integrity. Present the known and estimated locations of waste shipping points on a national map.

Describe the environmental impacts of the transportation of radioactive wastes to the facility under normal conditions. A site specific determination of impacts within the site region should be provided using the methods of Reference 2, as appropriate, or a similar technique. The site region is defined here to include all transportation routes to a distance of 320 kilometers (200 miles) from the facility or to include all routes over which there are more than five shipments per day whichever distance is greater. Provide a map of the site region with all transportation routes identified. A generic evaluation of impacts outside the site region should be provided using the methods of Reference 3 or similar analysis. Measures to reduce exposures to the public should be described.

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[1] Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I;" Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Power Reactors;" Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors;" Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I."

[2] J. M. Taylor and S. L. Daniel, "Radtran - A Computer Code to Analyze Transportation of Radioactive Material," SAND 76-0293, Sandia Laboratories, Albuquerque, NM, April 1977.

[3] NUREG-0170, Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes, December 1977.

The assessment of environmental impacts associated with the transportation of radioactive waste should consider factors such as: (1) the frequency of shipments and types and quantities of materials shipped over all routes; (2) the population density along all routes within the above site region; and (3) the total vehicle mileage traveled for each mode of transportation.

Environmental impacts other than radiological, such as air pollutants and noise, should also be considered. The environmental effects of the transportation of nonradiological material should also be described and evaluated.

## 6.7 Resources Committed

Any irreversible and irretrievable commitments of resources which are uniquely related to the repository operational phase should be presented here. The manner and scope of presentation should follow those of Section 5.4.

## 6.8 Socioeconomic Impacts[4]

### 6.8.1 Historic and Archeological Sites and Natural Landmarks

This section should present the following information: (1) a comprehensive disclosure of impacts; (2) the basis used for the analysis; and (3) conclusions regarding impacts of operational activities on historic and cultural resources. The following specific information should be included:

1. A description of the location and significance of those important historic or archeological resources identified by the applicant or local, State, or Federal agencies that are in or that might be eligible for inclusion in the National Register and that are within 16 kilometers of the proposed repository or within 2 kilometers of any associated service corridors;

2. State laws and plans for historic preservation;

3. The State Historic Preservation Officer's comments on the impact of this proposed repository on important archeological, historic, and natural feature resources; and

4. Where the impacts of operation are significantly different or greater than those described in Section 5.5.1, they should be described.

### 6.8.2 Social and Economic

This section should provide a statement of the scope of coverage and the objectives of the analysis; a summary of the steps taken in the analysis and referred to methodologies employed; a summary of the findings of the analysis

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[4]For additional information and guidance, NUREG-0158, "Draft Environmental Standard Review Plans for the Environmental Review of Construction Permit Applications for Nuclear Power Plants," Sections 5.1.3, 5.6.3, 5.8.1, 5.8.2, and 5.10, should be reviewed for applicability.

for each impact category; and an identification and assessment of potential mitigation measures. Impacts should be categorized as those resulting from repository operation and those resulting from the activities of the operating labor force.

The applicant should also include in the analysis the effects during the transition from the operational to isolation phase. Indicate when this transition period is likely to begin and end.

6.8.2.1 Repository Operation. This section should provide the following determinations:

1. The tax revenues derived from repository operation by jurisdiction;

2. The physical demands placed on local public facilities and services (e.g., fire, police, sewer, and water) by repository operation and compare these demands with existng facilities and services; and

3. If any impacts identified under land use, water use, and other system impacts require additional analysis regarding social and economic consequences.

6.8.2.2 Operation Labor Force. This section should provide the following information:

1. Estimate the operating staff requirements; predict the number of workers originating from within the region and the number of in-movers;

2. Determine labor wage rates and payroll;

3. Determine the family characteristics of in-movers; predict their geographic distribution;

4. Determine the number and family characteristics of induced in-movers; predict their geographic distribution;

5. Determine the overall impact of in-movers on regional income, employment, and population;

6. Compare by jurisdiction the flow of tax revenues generated by the operational payroll and induced economic activity;

7. Identify noteworthy changes that might occur in the social and political structure and character of impacted communities; identify major differential impacts on various social groups such as economic, occupational, or age groups; and

8. Describe the mechanism available to potentially impacted localities to plan for and accomodate change induced by the repository operational phase.

## 6.9 Transition from Operation to Isolation

In accordance with the objectives outlined in Chapter 1, the applicant should describe its plans and policies for the commissioning of the depository to the isolation phase. Provide an estimate of the time period to accomplish this transition from the operational to isolation phase. Discuss the consideration given in the design of the repository and associated support facilities relative to eventual commissioning of the depository and decommissioning of the surface facilities. Describe the amount of equipment and buildings to be dismantled and removed, and the procedures employed for closure of all penetrations from the ground surface to the depository. Information should be provided regarding the expected environmental impacts resulting from the outlined actions. The estimated present-worth monetary costs resulting from the implementation of these plans and policies should be considered in the cost-benefit analysis in Chapter 10.

## 6.10 Operational Monitoring Programs

The applicant should describe the general scope and objectives of its intended operational monitoring programs and provide a listing of parameters that it believes should be monitored for detailed evaluation. Any programs established to monitor repository effluents from operation or to make environmental measurements to confirm predictions about possible environmental effects should be discussed in detail. Each program should, to the extent feasible, utilize the baseline information and data presented in Chapter 3 for comparative purposes.

### 6.10.1 Nonradiological Monitoring

Nonradiological monitoring programs should be designed to detect any significant deleterious effects resulting from the operation of the facility or to confirm prior predictions relating to environmental effects. Procedures for mitigating adverse environmental effects, should they occur, which are detected by the monitoring programs should be discussed. Particular attention should be given to the monitoring of the spoil pile. However, any of the potential impacts discussed throughout this chapter are appropriate for an operational monitoring program.

### 6.10.2 Radiological Monitoring

6.10.2.1 Radiological Effluent Monitoring. The applicant should provide a description of periodic and continuous monitoring programs for radioactive airborne and waterborne effluents, including summary tables as appropriate.

For each location of possible effluent release provide:

1. The basis for selecting the location;

2. The expected range of concentrations of radionuclides or levels of radiation;

3. The quantity to be measured (e.g., external radiation level, gross concentration, radionuclide concentration, flow rate);

4. The detector type, detection limit and range considering items (1), (2), and (3) above and, for remote devices, the type and arrangement of the sampler, and estimates of sampling line interferences or losses;

5. Setpoints and the bases for their selection; and

6. The type and location of annunciators and alarms, and the system of operator actions which they initiate.

For each location subject to periodic sampling and analysis provide:

1. The basis for selecting the location;

2. Expected ranges of concentrations of radionuclides;

3. The quantity or quantities to be measured (e.g., gross radioactivity or radionuclide concentrations);

4. Sampling methods and frequency;

5. Radioanalytical procedure, frequency of analysis, and lower limit of detection;[5]

6. Influence of results on facility operations; and

7. Expected flow rates.

Describe how the results of the effluent monitoring program will be used to assess dose-equivalents to individuals and populations.

Describe the quality assurance program for effluent monitoring. Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring - Effluent Streams and the Environment," provides guidance on this subject.

6.10.2.2 Radiological Environmental Monitoring. The applicant should provide the rationale for the design of both the preoperational (initiated two years prior to waste receipt) and operational radiological environmental monitoring programs, including the relationship to potentially important pathways of radiation exposure to man and to the effluent monitoring program.[6]

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[5] The lower limit of detection (LLD), as defined in HASL-300, revised August 1974, should be stated for the 95% confidence level.

[6] Additional information is provided in the Radiological Assessment Branch's Technical Position, "An Acceptable Radiological Environmental Monitoring Program," available from the U.S. Nuclear Regulatory Commission.

The applicant should provide the following information for each sampling location:

1. Sample type, number of samples, sampling method (e.g., continuous, grab) and frequency;

2. Type of sample collection equipment;

3. Type and frequency of analysis and measurement;

4. The lower limit of detection for each analysis or measurement;

5. The schedule for reporting the results of the monitoring program;

6. Designation of sampling locations;

7. The quality assurance program for environmental monitoring (See Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring - Effluent Streams and the Environment" for guidance on this subject.); and

8. Criteria to be used for investigating increases of concentrations of radioactive materials detected in the environment.

# CHAPTER 7. ENVIRONMENTAL EFFECTS OF WASTE ISOLATION PHASE

This chapter should discuss the expected environmental effects resulting from the repository upon commencement of the waste isolation phase. The presentation should follow the same manner and scope of the previous Chapters 5 and 6.

## 7.1 Land Use Impacts

The applicant should indicate the amount of land that will be dedicated to the repository after all penetrations from the ground surface to the depository have been sealed and after dismantling of the surface support facilities. Indicate the original uses of these areas from the information provided in Section 3.1.3. Describe the direct limitations that will be placed on land use in the site vicinity (e.g., exploration of natural resources). Assess the probable impacts of the repository isolation phase on land use of adjacent areas to establish if any would be severe enough to result in a change of land use patterns in the site vicinity.

Estimate expected impacts on the site area as a result of subsidence. Indicate the projected thermal loadings at the surface of the repository. Discuss the projected long-term impacts on the flora and fauna in the vicinity of the site, their habitats, and their distribution. Relate any other probable environmental impacts and effects on land use that may occur in this phase.

## 7.2 Water Use Impacts

Describe the anticipated changes on regional water, in particular, groundwater, as a result of the facility in the waste isolation phase. Discuss how these changes may impact water supplies in the site area. Categorize these changes as physical, chemical, and thermal. Discuss the projected long-term impacts to the ecosystems in the vicinity of the site.

## 7.3 Nonradiological Waste Impacts

Identify any residual nonradiological wastes that will remain from the construction and operational phases (such as spoil piles). The sources, quantities, and composition of these wastes should be estimated. Evaluate the long-term effects of these waste. Describe the extent of compliance with applicable local, State, and Federal regulations and guidelines.

Identify and quantify the impacts to the ecosystems resulting from the residual nonradiological wastes. Appropriate references to the baseline data in Chapter 3 and the evaluations in Chapters 5 and 6 should be made. Discuss the measures and controls planned to limit any adverse impacts identified.

## 7.4 Long-Term Effects on Geologic Environment

This section should identify and discuss those effects previously presented in Section 6.4 that will result in environmental impacts during the waste isolation phase, in addition to the effects resulting from the sealing of all

penetrations from the ground surface to the depository. The manner and scope of the presentation should follow those of Section 6.4.

## 7.5 Radiological Effects

Indicate the expected long-term radiological releases from the repository as a function of time during the waste isolation phase. Estimate the corresponding exposures to the general public. Identify the potential sources and their associated causes of these releases.

The appropriate calculational models, techniques, and data presented in Chapter 3 and Section 6.5 should be used in estimating the doses to individuals and to the population within 80 kilometers of the facility. Calculational models and techniques should be discussed in detail with reference to appropriate documentation of their development and verification.

Potential biological effects should be estimated and presented based on exposures. The models used to obtain the estimates should also be presented. Ranges of uncertainty and the factors influencing the uncertainty in consequences should be discussed.

## 7.6 Resources Committed

Any irreversible and irretrievable commitments of resources which are uniquely related to the repository during the waste isolation phase should be presented here. The manner and scope of presentation should follow those of Section 5.4.

## 7.7 Socioeconomic Impacts

This section should provide information on the the socioeconomic consequences to the dependent community of closing the operation of the repository. Specifically, it should include the potential socioeconomic impacts, and a comparison of the economic base of the community before and after repository isolation to determine the magnitude of potential impacts.

## 7.8 Isolation Performance Monitoring Program

The monitoring program which will be used to evaluate the effectiveness of the geologic disposal effort should be discussed. The program should be discussed in two parts. The first part should discuss programs enacted prior to closing penetrations to determine: waste form performance, waste-host rock interactions, steady state temperature distributions, response of local geologic environment to presence of repository, effects of repository on groundwater hydrology, etc. The second part should present a general discussion of any programs, including their time periods, implemented after the repository penetrations have been sealed to detect evidence of: radionuclide migration, increase of groundwater transport in the vicinity of the repository excavations, or penetration of the repository by human activities. Differentiation should be made between those portions which require administrative controls and those which do not.

# CHAPTER 8. ENVIRONMENTAL EFFECTS OF ACCIDENTS

In this chapter, the applicant should discuss the potential environmental effects of accidents involving the repository.

## 8.1 Repository Accidents Not Involving Radioactivity

Accidents may occur as a result of repository construction and operation that, although they do not involve radioactive materials, have consequences that may affect the environment. Incidents such as chemical explosions (particularly near mining operations), fires, leakage rupture of vessels containing oil or toxic materials, and transportation accidents can have significant environmental impact. These possible accidents and associated effects should be identified and evaluated.

## 8.2 Repository Accidents Involving Radioactivity

Accidents may occur during repository operation which will cause the release of limited amounts of radioactivity. Such accidental releases may expose workers or members of the public to levels of radiation in excess of those normally encountered. The applicant should attempt to identify potential accidental release mechanisms and evaluate the probability and severity of the effects of such events. Particular attention should be given to the definition and evaluation of the effects of the postulated maximum credible accident. (Detailed considerations of accidents in the license application can be referenced to avoid duplication). Descriptions of events which can be expected to happen after waste receipt should be accompanied by specific discussion of measures which are intended to reduce either the probability or the consequences of occurrence. The discussions should include surface and subsurface accidents.

## 8.3 Transportation Accidents Involving Radioactivity

Describe the environmental impacts of transportation accidents involving radioactive waste. The approach used in NUREG-0170 is an acceptable way to evaluate transportation impacts outside the site region (as defined in Section 6.6). For transportation within the site region, a site specific evaluation should consider such factors as local accident rates, unusual route characteristics, normal (existing) traffic densities on the routes, and actual population densities. The data used for such regional characteristics should be presented and the sources should be documented. Plans for accident contamination cleanup should be described.

# CHAPTER 9. DESIGN ALTERNATIVES

This chapter should indicate the manner in which the applicant arrived at the design of the proposed facility through the consideration of the environmental effects of alternative systems.

The significant environmental effects of a waste repository will be dependent upon the final design of systems which provide the interface of the repository with the environment. Systems or combinations of systems may represent different balances of economic and environmental costs. The applicant's preferred choice will be the result of a cost-effectiveness comparison designed to optimize the balance between economic cost and environmental protection. The information in this chapter should be sufficient to support an independent assessment of the alternatives to the systems or combinations of systems preferred by the applicant. In addition to repository systems, various construction methods and practices represent alternatives which may have different environmental consequences. These alternative construction methods should be considered, if appropriate. Alternative designs for the following list of systems, components, and structures might be considered in this chapter:

1. Waste form
2. Waste packages, overpacks, and other engineered barriers
3. Shaft construction and excavation techniques
4. Shaft and excavation sealing techniques
5. Tunnel and shaft layouts
6. Drift design
7. Backfill techniques
8. Waste handling systems
9. Retrieval techniques
10. Spoil pile maintenance
11. Sanitary waste systems
12. Radwaste systems
13. Service corridors
14. Ventilation systems

15. Power and communication lines

16. Water supply

17. Dewatering techniques

18. Decontamination facilities

19. Onsite encapsulation techniques

20. Other systems

The range of alternative systems considered by the applicant should include those alternative facility systems that appear promising in terms of environmental protection. Different designs for systems that are essentially identical with respect to environmental effects should be considered only if their economic costs are appreciably different. The applicant should consider those alternative systems that provide improved levels of environmental protection.

The capital and operating costs of individual systems and their alternatives should be presented in absolute terms. These monetized costs should be set forth in some uniform economic analysis (e.g., present-worth to the date of receipt of waste) so that valid comparisons can be made between alternatives.

The environmental effects of the alternative systems (as well as the proposed system) should be documented and supported by available information. To the extent practicable, the magnitude of each effect should be quantified. Where quantification is not possible, qualitative evaluations should be expressed in terms of a comparison to the effects of the proposed system. In either case, the derivation of the evaluations should be completely documented.

# CHAPTER 10. SUMMARY COST-BENEFIT ANALYSIS

This chapter should demonstrate through a cost-benefit analysis of the proposed facility why in the applicant's judgement the aggregate benefits outweigh the aggregate costs. A concise presentation of the positive (benefits) and negative (costs) aspects of the proposal should be provided in tabular form and categorized as regional or national effects.

The benefits and costs identified throughout the report should be considered for the analysis. If items have not been previously identified, they should be indicated and included in the analysis.

The commensurable nature of the benefits and costs make it virtually impossible to provide a concise assessment in classical quantitative terms. Even though a simple numerical weighing of benefits against costs is clearly not feasible here, the applicant can evaluate the factors on a judgmental and qualitative basis that is consistent with the underlying concept of cost-benefit analysis.

# CHAPTER 11. ENVIRONMENTAL APPROVALS AND CONSULTATION

## 11.1 Official Approvals and Consultations

List all licenses, permits, and other approvals, including the appropriate legal references, for facility construction, operation, and isolation required by Federal, State, local, and regional authorities. For each approval provide the following information in tabular form: (1) the corresponding authority; (2) the purpose (e.g., discharging effluents, obtaining land, transportation of waste); (3) the applicable limits and conditions; and (4) the status, including the date of application and expected date of issuance. Also discuss any consultations or coordination with organizations regarding the facility and the associated environmental impacts identified.

## 11.2 Public Involvement

List any public hearings held or to be held which relate to facility construction, operation, or isolation. Identify the subject and need for these hearings and, if the hearings have been held, summarize the concerns raised, the dates and locations of the hearings, and indicate the estimated number in attendance.

Discuss general public information efforts that are not required by law or regulation. Indicate actions taken to involve or inform the public during the site selection process, whether it was initiated during screening for alternative sites, during selection of the preferred site, or at some time afterward. List (with a summary of discussions, including the structure and purpose, and the number attending) all public meetings held with the general public and/or special interest groups in an effort to raise public awareness and to receive public concerns regarding the proposed action.

Describe the use of the media to educate and inform the public of the proposed action, need for the facility, and associated costs and benefits of the facility.

Discuss coordination efforts with local, regional, and State agencies and organizations regarding potential socioeconomic impacts of the facility and their subsequent mitigation.

# CHAPTER 12. REFERENCES

The applicant should provide a bibliography of sources used in preparation of the environmental report. References should be cited by numerical designation and listed at the end of the chapter to which they refer.

# APPENDIX A
# 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 kilometers (50 miles) 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 facility 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.[1]

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 facility is to be located. Obtain the age distribution of the region from the above reference. For example, the 0-11-year age group population for the BEA area at the midpoint year of an assumed 30-year operational phase of the proposed facility 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 facility operational phase. Specific 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:

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[1] Henry De Graff, Assistant Chief, Regional Economic Analysis Division, Bureau of Economic Analysis, U.S. Department of Commerce, Washington, D.C. 20230; Telephone: (202) 523-0528.

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

where

A = % of BEA region population forecasted to be in the 12- to 18-year age group at the midpoint year of facility operation.

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

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

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

A is then used to estimate the number of persons in that age group for the area within 80 kilometers 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.