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PREPARATION OF ENVIRONMENTAL REPORTS FOR NUCLEAR POWER STATIONS

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REGULATORY GUIDE

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TABLE OF CONTENTS

Page

TABLES

APPENDICES

TABLES

APPENDICES

Page

A. INTRODUCTION

1. National Environmental Goals

Prior to the issuance of a construction permit or an operating license for a nuclear power station, the U.S. Nuclear Regulatory Commission is required to assess the potential environmental effects of that facility in order to assure that issuance of the permit or license will be consistent with the national environmental goals, as set forth by the National Environmental Policy Act of 1969 (Pub. Law 91-190, 83 Stat. 852). In order to obtain information essential to this assessment, the Commission requires each applicant for a permit or a license to submit a report on the potential environmental impacts of the proposed plant and associated facilities.

The national environmental goals as expressed by the National Environmental Policy Act (NEPA) are as follows:

> "... it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may–
>
> "(1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
>
> "(2) assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;
>
> "(3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
>
> "(4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice;
>
> "(5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and
>
> "(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources."

The Commission's implementation of NEPA[1] is contained in 10 CFR Part 51, "Licensing and Regulatory Policy and Procedures for Environmental Protection." Other relevant information is contained in the proposed Annex, "Discussion of Accidents in Applicants' Environmental Reports: Assumptions," to Appendix D, 10 CFR Part 50 published in 36 FR 22851 and in the proposed Section F, "Consideration of Transportation in Applicants' Environmental Reports and AEC Detailed Statements Pertaining to Light-Water-Cooled Nuclear Power Reactors," of Appendix D, 10 CFR Part 50 (36 FR 22851).

[1] See also CEQ Guidelines (38 FR 20549) published August 1, 1973.

2. Applicant's Environmental Reports

Part 51 of Title 10 of the Code of Federal Regulations discusses in §§ 51.20 and 51.21, presented below, the general requirements for Environmental Reports (ERs).

> **"51.20 Applicant's Environmental Report–Construction Permit Stage**
>
> "(a) Environmental Considerations. Each applicant[2] for a permit to construct a production or utilization facility covered by §51.5(a) shall submit with its application a separate document, entitled 'Applicant's Environmental Report–Construction Permit Stage,' which contains a description of the proposed action, a statement of its purposes, and a description of the environment affected, and which discusses the following considerations:
>
> "(1) the probable impact of the proposed action on the environment;
>
> "(2) any probable adverse environmental effects which cannot be avoided should the proposal be implemented;
>
> "(3) alternatives to the proposed action;
>
> "(4) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and
>
> "(5) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. The discussion of alternatives to the proposed action required by paragraph (a)(3) shall be sufficiently complete to aid the Commission in developing and exploring, pursuant to section 102(2) (D) of NEPA, 'appropriate alternatives * * * in any proposal which involves unresolved conflicts concerning alternative uses of available resources.'
>
> "(b) Cost-Benefit Analysis. The Environmental Report required by paragraph (a) shall include a cost-benefit analysis which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects, as well as the environmental, economic, technical and other benefits of the facility. The cost-benefit analysis shall, to the fullest extent practicable, quantify the various factors considered. To the extent that such factors cannot be quantified, they shall be discussed in qualitative terms. The Environmental Report should contain sufficient data to aid the Commission in its development of an independent cost-benefit analysis.

[2] Where the "applicant," as used in this part, is a Federal agency, different arrangements for implementing NEPA may be made, pursuant to the Guidelines established by the Council on Environmental Quality.

"(c) Status of Compliance. The Environmental Report required by paragraph (a) shall include a discussion of the status of compliance of the facility with applicable environmental quality standards and requirements (including, but not limited to, applicable zoning and land-use regulations and thermal and other water pollution limitations or requirements promulgated or imposed pursuant to the Federal Water Pollution Control Act) which have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection. The discussion of alternatives in the Report shall include a discussion whether the alternatives will comply with such applicable environmental quality standards and requirements. The environmental impact of the facility and alternatives shall be fully discussed with respect to matters covered by such standards and requirements irrespective of whether a certification or license from the appropriate authority has been obtained (including, but not limited to, any certification obtained pursuant to Section 401 of the Federal Water Pollution Control Act[3]). Such discussion shall be reflected in the cost-benefit analysis prescribed in paragraph (b). While satisfaction of Commission standards and criteria pertaining to radiological effects will be necessary to meet the licensing requirements of the Atomic Energy Act, the cost-benefit analysis prescribed in paragraph (b) shall, for the purposes of NEPA, consider the radiological effects, together with the other effects, of the facility and alternatives.

"(d) The information submitted pursuant to paragraphs (a)-(c) of this section should not be confined to data supporting the proposed action but should include adverse data as well.

"(e) In the Environmental Report required by paragraph (a) for light-water-cooled nuclear power reactors, the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low level wastes and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power reactor shall be as set forth in [Table 1]. No further discussion of such environmental effects shall be required.

"This paragraph does not apply to any applicant's environmental report submitted prior to June 6, 1974.

"(f) Number of copies. Each applicant for a permit to construct a production or utilization facility covered by §51.5(a) shall submit 200 copies of the Environmental Report required by paragraph (a).

[3]No permit or license will, of course, be issued with respect to an activity for which a certification required by Section 401 of the Federal Water Pollution Control Act has not been obtained.

"51.21 Applicant's Environmental Report—Operating License Stage

"Each applicant for a license to operate a production or utilization facility covered by §51.5(a) shall submit with its application 200 copies of a separate document, to be entitled "Applicant's Environmental Report—Operating License Stage," which discusses the same matters described in §51.20 but only to the extent that they differ from those discussed or reflect new information in addition to that discussed in the final environmental impact statement prepared by the Commission in connection with the construction permit. The 'Applicant's Environmental Report—Operating License Stage' may incorporate by reference any information contained in the Applicant's Environmental Report or final environmental impact statement previously prepared in connection with the construction permit. With respect to the operation of nuclear reactors, the applicant, unless otherwise required by the Commission, shall submit the 'Applicant's Environmental Report—Operating License Stage' only in connection with the first licensing action that would authorize full power operation of the facility."

3. Federal Water Pollution Control Act

As provided in the "Interim Policy Statement," 38 FR 2679, the Federal Water Pollution Control Act (FWPCA) Amendments of 1972 (Pub. Law 92-500, 86 Stat. 816) affects the Nuclear Regulatory Comission's responsibilities under the National Environmental Policy Act of 1969 (NEPA). The Commission's NEPA responsibilities will be modified as various implementing actions are taken under the FWPCA, and appropriate changes will be made in this guide. However, since the Commission will, in any event, continue to evaluate environmental impact, the basic scope and content of the information needed to prepare an environmental report, as set forth in this guide, will remain unchanged.

In cases where the proposed system in the application does not comply with thermal effluent limitations under Sections 301 and 306 of Pub. Law 92-500 and no disposition of any request for waiver under Section 316(a) is expected until after issuance of a construction permit, the Environmental Report (ER) should clearly identify and provide supporting analysis for the most feasible alternative cooling system that would be selected in the event the request for modification is denied.

4. Commission Action on Environmental Reports

As noted in §51.50, "Federal Register notices; distribution of reports; public announcements; public comment," of 10 CFR Part 51, the Commission places a copy of each applicant's environmental report in the NRC's Public Document Room in Washington D.C. and in a local public document room near the proposed site. The report is also made available to the public at the appropriate State, regional, and metropolitan clearinghouses. At the same time, a public announcement is made and a summary notice published in the *Federal Register.*

The applicant's environmental report, relevant published information, and any comments received from interested persons are considered by the Regulatory staff in preparing a "Draft Environmental Statement" concerning the proposed licensing action. The Regulatory staff's draft statement and the applicant's environmental report are transmitted for information to the Council on Environmental Quality, and for comment to Federal agencies having jurisdiction by law or special expertise or who are authorized to develop and enforce environmental standards, and to the Governor or appropriate State and local officials who are authorized to develop and enforce environmental standards of any affected State. Comments on the report and the draft statement are requested within a specified time interval. The draft statement is made available to the general public in the same manner as is the report. These activities are based on §§51.22, 51.24, and 51.25 of 10 CFR Part 51.

As described in detail in §51.26 of 10 CFR Part 51, the Regulatory staff considers the comments on the report and on the draft statement received from the various Federal, State, and local agencies and officials, from the applicant, and from private organizations and individuals and prepares a "Final Environmental Impact Statement." The final statement is transmitted to the Council on Environmental Quality and is made available to appropriate Federal, State, and local agencies and State, regional, and metropolitan clearinghouses. A public announcement is made and a notice of availability is published in the *Federal Register.*

Subsequent hearings and actions as described in Subpart D, "Administrative Action and Authorization; Public Hearings and Comment," of 10 CFR Part 51 on the environmental aspects involved in issuance of a construction permit or operating license are based on the applicant's environmental report and on the Commission's "Final Environmental Impact Statement" (FES). The environmental impact statement takes into account information from many sources, including the applicant's environment report and its supplements, and the comments of the various governmental agencies, the applicant, and private organizations and individuals.

The applicant's environmental report is an important document of public record. Therefore, the applicant is urged to give full attention to its completeness.

5. General Considerations Related to Environmental Reports

a. Cost-Benefit Analysis

The cost-benefit analysis referred to in paragraph (b) of §51.20 (10 CFR Part 51) should consist of two parts. In the first part, alternative site-plant combinations and plant systems should be examined in order to determine whether the proposed facility is the cost-effective choice, considering economic, social, and other environmental factors, and any institutional (governmental, etc.) constraints.

Where the cost effectiveness of siting involves questions of population density, the cumulative population projected for the time interval between the date of application for a construction permit and the end of plant lifetime should be determined.

The applicant should refer to specific guidance on population density criteria[4] which the Regulatory staff will issue from time to time. Where population density is critical to site acceptance, the applicant should provide:

(1) An analysis of alternative sites, showing that the proposed site offers significant advantages from the standpoints of environmental, economic, or other factors.

(2) The cost of additional state-of-the-art engineered safety features that would be necessary to assure that the conservatively calculated consequences of postulated design basis accidents are significantly below the dose guidelines of 10 CFR Part 100, "Reactor Site Criteria."

(3) A detailed study of projected economic and population growth patterns for the 10 years following the date of application for the construction permit.

In the second part of the cost-benefit analysis, the benefits to be created by the proposed facility should be weighed against the aggregate of environmental, economic and other costs to be incurred.

b. Construction Permit and Operating License Stages

Sections 51.20 and 51.21d of 10 CFR Part 51 require the applicant to submit two environmental reports. The first is the "Applicant's Environmental Report–Construction Permit Stage," which must be submitted in conjunction with the construction permit application. The second is the "Applicant's Environmental Report–Operating License Stage," which must be submitted later in conjunction with the operating license application.

The applicant should present, in the environmental report that is submitted with the application for a construction permit, sufficient information to permit Regulatory staff evaluation of the potential environmental impact of constructing and operating the proposed facility. In all cases, the site-specific environmental data presented at the time of filing for a construction permit (1) should fully document the critical life stages and biologically significant activities

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[4] "General Site Suitability Criteria for Nuclear Power Stations," Regulatory Guide 4.7, issued for comment September 1974.

(e.g., spawning, nesting, migration) that increase the vulnerability of the potentially affected biota at the proposed site and (2) should be adequate to characterize the seasonal variations of biota likely to be affected by the plant. An applicant wishing to accelerate the start of plant construction by early submittal of the environmental report (according to the procedure set forth in 10 CFR Part 50, §50.10(c), may submit an initial evaluation of environmental impact based on an analysis of at least six months of field data related to the proposed facility and suitable projections of the remaining seasonal periods provided that the first of the foregoing conditions is met. If this is done, the applicant should also make a commitment to furnish, within six months of the time of filing, a final evaluation based on a full year of field data.

The "Applicant's Environmental Report–Operating License Stage" should, in effect, be an updating of the earlier report and should:

(1) Discuss differences between currently projected environmental effects of the nuclear power plant (including those which would degrade and those which would enhance environmental conditions) and the effects discussed in the environmental report submitted at the construction stage. (Differences may result, for example, from changes in plans, changes in plant design, availability of new or more detailed information, or changes in surrounding land use, water use, or zoning classifications.)

(2) Discuss the results of all studies that were not completed at the time of preconstruction review and which were specified to be completed before the preoperational review. Indicate how the results of these studies were factored into the design and proposed operation of the plant.

(3) Describe the scope of the monitoring programs that have been and will be undertaken to determine the effects of the operating plant on the environment. Include any monitoring programs being developed or carried out in cooperation with State and Federal fish and wildlife services. The result of preoperational monitoring activities should be presented in summary and interpretive form (refer to Chapter 6 of Section B of this guide). A listing of types of measurements, kinds and numbers of samples collected, frequencies, and analyses should be provided and the locations described and indicated on a map of the area.

(4) Discuss planned studies, not yet completed, that may yield results relevant to the environmental impact of the plant.

(5) Propose environmental technical specifications. The format for these specifications will be presented in a regulatory guide entitled "Guide for the Preparation of Environmental Technical Specifications for Nuclear Power Plants," which is currently being developed. Detailed technical specifications may become an appendix to the applicant's "Environmental Report–Operating License Stage," but the body of the report need only include the required discussion of general scope described in Section 6.2 of this guide. Interim guidance will continue to be provided on a case-by-case basis.

6. Preparation of Environmental Reports

a. General Organization

Section 2 of this Introduction, especially the paragraphs quoted from 10 CFR Part 51, provides general information concerning the content of the applicant's environmental report. To provide specific and detailed guidance, Section B of this guide, "Standard Format and Content of Environmental Reports," has been prepared. Although conformance is not required, the format and content described are acceptable to the Regulatory staff. Environmental reports with different formats or content will be acceptable to the staff if they provide an adequate basis for the findings required for the issuance of a license or permit; however, conformance with the format and content will expedite staff review. The Regulatory staff plans to provide additional information on a data retrieval system (outlined in Appendix 1) in the next revision of this guide.

b. Content

In order to cover a wide variety of anticipated situations, the guide scope is comprehensive. In some instances, requests for specific information may not be applicable to a particular plant or site.

Some of the guide text (e.g., Section 7.1) has been written with specific reference to light-water reactors. For applicants proposing to construct and operate other reactor types, guidelines on the recommended content of these sections will be provided on a case-by-case basis. Similarly, offshore power systems will, in general, require special guidelines for each individual case.

Some of the information to be included in the environmental report (e.g., that pertaining to demography, meteorology, hydrology) may have already been prepared by the applicant during consideration of the safety aspects of the proposed facility. In such cases, this information (whether in the form of text, tables, or figures) should be incorporated in the environmental report where appropriate to avoid duplication of effort. The presentation in the environmental report of some information which also appears in the applicant's safety analysis report is necessary because these reports are responsive to different statutory requirements and because each report should be essentially self-contained.

Descriptive and/or narrative text, as well as tables, charts, graphs, etc., should be used in the report. Each subject should be treated in sufficient depth and should be documented[5] to permit a reviewer to evaluate the extent of the environmental impact independently. The length of an environmental report will depend on the nature of the plant and its environment. Tables, line drawings, and photographs should be used wherever contributory to the clarity and brevity of the report. Descriptive and narrative passages should be brief and concise. The number of significant figures stated in numerical data should reflect the accuracy of the data.

Pertinent published information relating to the site, the plant, and its surroundings should be referenced. Where published information is essential for evaluation of specific environmental effects of the plant construction and operation, it should be included, in summary or verbatim form, in the environmental report or as an appendix to the report. In particular, water quality standards and regulations relevant to the environmental impact assessment should be given in an appendix. Reports of work supported by the applicant which the applicant considers contributory to the environmental impact analysis may be included as appendices.

c. Other Facilities at a Site

The site for a nuclear power plant may already contain one or more "units" (i.e., steam-electric plants), either in being or under construction or for which an application for a construction permit or operating license has been filed. The applicant, in preparing the environmental report relating to such a site, should consider the effects of the proposed plant (and its inservice schedule) in conjunction with the effects of such additional plants. Furthermore, if the site contains significant sources of environmental impact other than electric power plants, their interactions with the proposed plant should be taken into account.

Interplant effects are considered especially important as efforts to conserve resources such as water focus on the transfer and reuse of materials within plant complexes. In addition, because the control of radioactive effluents is solely a responsibility of the Commission, adjacent or contiguous facilities involving the potential interchange of radionuclides should be treated in considerable detail to ensure the applicant's full knowledge of interrelationships with the proposed plant.

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[5] "Documentation" as used in this guide means presentation of evidence supporting data and statements and includes (1) references to published information, (2) citations from the applicant's experience, and (3) reference to unpublished information developed by the applicant or the applicant's consultants. Statements not supported by documentation are acceptable provided the applicant identifies them either as information for which documentation is not available or as expressions of belief or judgment.

B. STANDARD FORMAT AND CONTENT OF ENVIRONMENTAL REPORTS

CHAPTER 1

PURPOSE OF THE PROPOSED FACILITY AND ASSOCIATED TRANSMISSION

In Chapter 1 of his environmental report, the applicant should demonstrate the need for the proposed facility with respect to the power requirements to be satisfied, the system reliability to be achieved, any other primary objectives of the facility, and how these objectives would be affected by a delay in the scheduled operation of the proposed plant.

1.1 Need for Power

This section should discuss the requirements for the proposed nuclear unit(s) in the applicant's system and in the region, considering the overall power supply situation, past load and projected load, and reserve margins. In addition, the applicant should consider the expected effects of national energy conservation programs on his planning effort. Apparent inconsistencies between the data presented and that furnished to the Federal Power Commission (FPC) or the regional reliability council should be explained.

1.1.1 Load Characteristics

In order to portray the relationship of the proposed facility to the applicant's system and related systems, data should be provided on the following: (a) the applicant's system, (b) the power pool or area within which the applicant's planning studies are based, and (c) where available, the regional reliability council or the appropriate subregion or area of the reliability council as follows:

1.1.1.1 Load Analysis. The past annual peak load demands and the annual energy requirements for a period beginning ten years prior to the filing of the environmental report should be reported, as well as the future projected annual peak demands and energy requirements for at least two years of the FPC reporting period following start of commercial operation of the last unit with which this report is concerned. To the extent feasible, the applicant should also present future demands during the expected life of the facilities under review. The relationship of the proposed facility to the capacity increments specified in reports emanating from FPC Order 383-3 should be detailed.

The applicant should present the expected annual load duration curve for the first two full annual FPC reporting periods for the proposed nuclear station in order to show the relationship of the station to the short term system requirements.

1.1.1.2 Demand Projections. Demand projections should show explicitly any assumptions made about economic and demographic projections. Specifically, any changes in demand expected on the basis of alternative assumptions made about household formation, migration, personal income, and industrial and commercial construction volume and location should be specified. Past and future growth trends should be compared and explanations should be given for deviations in trends.

Monthly data for both actual and previously forecast peak load should be provided, as well as both actual and previously forecast total monthly kWh sales from October 1972 through the most current month. A copy of the reports supplied to the FPC in accordance with FPC Order 496 should also be provided.

1.1.1.3 Power Exchanges. Past and expected future net power exchanges applicable at the time of the annual peak demands presented above should be shown as they relate to demand estimates supporting the station capacity under review.

1.1.2 System Capacity

The applicant should briefly discuss power planning programs and criteria used as they apply (a) to the applicant's system, (b) to the power pool or area within which the applicant's planning studies are based, and (c) to the regional reliability council or the appropriate subregion or area of the reliability council. System capabilities, both existing and planned, should be tabulated for the three respective areas to the extent applicable at the time of the annual peak demand for five years preceding filing of the environmental report through at least five years beyond the start of commercial operation of the last nuclear unit with which the report is concerned. Each generator with a capacity of 100 MWe or over should be listed separately for the initial reporting year, and capability additions thereafter should be separately tabulated by date, including net non-firm-power sales and purchases, retirements or deratings, and upratings. Each generator should be categorized as to type (hydro, fossil, nuclear, pumped storage, etc.) and as to function (base load, intermediate, peaking, etc). Estimates of projected capacity factor ranges for each unit tabulated should be provided. Small peaking units may be lumped into a single category for simplicity.

1.1.3 Reserve Margins

The applicant's method of determining system generating capacity requirements and reserve margins should be described including:

1. The method and criterion employed to determine the minimum system reserve requirement, such as single largest unit, probability method, or historical data

and judgment. If probabilistic studies are used as a planning tool, the results should be stated along with the significant input data utilized, such as the load model generating unit characteristics, unit availability, the duration of periods examined, treatment of interconnections, and a general description of the methodology employed.

2. The effect of operation of the proposed nuclear unit(s) on the applicant's or planning entity's capacity requirements. In addition, the effects of present and planned interconnections on the capacity requirements should be discussed.

3. The reserve margin responsibility of participants in the regional coordinating council or power pool.

1.1.4 External Supporting Studies

Reports should be summarized and referenced or statement(s) included that indicate the power requirements in the overall area(s), as determined by responsible officials in the regional reliability council and/or the power pool or planning entity with which the applicant is associated.

The report or statements should include the following information or a statement that such information is not available:

1. Description of the minimum installed reserve criterion for the region and/or subarea;

2. Identification, description, and brief discussion of studies and/or analyses made to assess the area-wide adequacy and expected reliability of power supply for the first full year of commercial operation of the entire station covered in this report; and

3. The minimum reserve requirement in the region and/or subarea for the first year of operation of the completed nuclear station.

1.2 Other Objectives

If other objectives are to be met by the proposed facility, such as producing process steam for sale or desalting water, a description of these should be given. An analysis of the effect of other objectives on the station capacity factor or availability of individual units should be given.

1.3 Consequences of Delay

The effects of delays in the proposed project on the reserve margin of the power supply for the applicant's system, subregion, and region should be discussed for increments of delay of 1, 2, and 3 years. The effect of no action to increase capacity should also be illustrated.

CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

This chapter should present the basic relevant information concerning those physical, biological, and human characteristics of the area environment that might be affected by the construction and operation of a nuclear power plant on the designated site. To the extent possible, the information presented should reflect observations and measurements made over a period of years.

2.1 Geography and Demography

2.1.1 Site Location and Description

2.1.1.1 Specification of Location. The site location should be specified by latitude and longitude of the reactor 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.

2.1.1.2 Site[6] Area. A map of the site area of suitable scale (with explanatory text as necessary) should be included; it should clearly show the following:

1. The plant property lines. The area of plant property in acres should be stated.
2. Location of the site boundary. If the site boundary lines are the same as the plant property lines, this should be stated.
3. The location and orientation of principal plant structures within the site area. Principal structures should be identified as to function (e.g., reactor building, auxiliary building, turbine building).
4. The location of any industrial, recreational, or residential structures within the site area.
5. The boundary lines of the plant exclusion area (as defined in 10 CFR Part 100). If these boundary lines are the same as the plant property lines, this should be stated. The minimum distance from each reactor to the exclusion area boundary should be shown and specified.
6. A scale which will permit the measurement of distances with reasonable accuracy.
7. True north.
8. Highways, railways, and waterways which traverse or are adjacent to the site.

2.1.1.3 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 §20.106(a) (and related as low as practicable provisions) be set, the information required by §20.106 should be submitted. The site map discussed above may be used to identify this area, or a separate map of the 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 plant effluent release points to the boundary line should be defined clearly.

2.1.2 Exclusion Area Authority and Control

2.1.2.1 Authority. If ownership of all land within the exclusion area has not been obtained by the applicant, those parcels of land within the area not so owned should be clearly described by means of a scaled map of the exclusion area, and the status of proceedings to obtain ownership or control over the land for the life of the plant should be specifically described. Minimum distance to and direction of exclusion area boundaries should be given for both present ownership and proposed ownership.

2.1.2.2 Control of Activities Unrelated to Plant Operation. Any activities unrelated to plant operation which are to be permitted within the exclusion area (aside from transit through the area) should be described with respect to the nature of such activities, the number of persons engaged in them, and the specific locations within the exclusion area where such activities will be permitted.

2.1.3 Population Distribution

Population data presented should be based on the 1970 census data and, where available, more recent census data. The following information should be presented on population distribution.

2.1.3.1 Population Within 10 Miles. On a map of suitable scale which identifies places of significant population grouping, such as cities and towns within a 10-mile radius, concentric circles should be drawn, with the reactor at the center point, at distances of 1, 2, 3, 4, 5, and 10 miles. The circles should be divided into 22-1/2-degree sectors with each sector centered on one of the 16 cardinal 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

[6] "Site" means the contiguous real estate on which nuclear facilities are located and for which one or more licensees has the legal right to control access by individuals and to restrict land use for purposes of limiting the potential doses from radiation or radioactive material during normal operation of the facilities.

projected population within each area for (1) the expected first year of plant operation and (2) by census decade (e.g., 1990) through the projected plant life. The tables should provide population totals for each sector and annular ring, and a total for the 0 to 10 miles enclosed population. The basis for population projections should be described.

2.1.3.2 Population Between 10 and 50 Miles. 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 10-mile intervals between the 10- and 50-mile radii from the reactor.

2.1.3.3 *Transient Population.* Seasonal and daily variations in population and population distribution resulting from land uses such as recreational or industrial should be generally described and appropriately keyed to the areas and population numbers contained on the maps and tables of Paragraphs 2.1.3.1 and 2.1.3.2. If the plant 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.

2.1.4 Uses of Adjacent Lands and Waters

On detailed topographical maps, show the locations of the plant perimeter, exclusion 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 historic, scenic, cultural, recreational, or natural areas, and transportation links (railroads, highways, waterways). Indicate the total acreage owned by the applicant and that part occupied or modified by the plant and plant facilities. Indicate other existing and proposed uses, if any, of applicant's property and the acreage devoted to these uses. Describe any plans for site modifications, such as a visitors center or park.

Provide, in tabular form, the distances from the centerline of the first operational nuclear unit proposed to the following for each of the 16 sectors described in Subsection 2.1.3 above:

1. Nearest milk cow (to a distance of 5 miles)
2. Nearest milk goat (to a distance of 15 miles)
3. Nearest residence (to a distance of 5 miles)
4. Nearest site boundary
5. Nearest vegetable garden (to a distance of 5 miles)

Indicate which, if any, of the cow and goat locations are dairy operations.

Indicate (for the 5-mile-radius area) the nature and extent of present and projected land use (agriculture, livestock raising, dairies, pasturelands, residences, wildlife preserves, sanctuaries, hunting areas, industries, 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 5 miles of the reactor building location and any local plans to restrict development to limit population encroachment.

The information in this section should be organized in a manner that demonstrates coordination of the principal activities of the proposed station with the various uses of land and water outside the station. These activities should include details of required offsite access corridors such as railroad spurs, rights-of-way for cooling water conveyance, new or future roadways, and other cultural features that relate to the principal purpose of the facility. The discussion should include reference to the reservation of rights-of-way for any future expansions that might be foreseen at the time of the application.

Indicate the nature and amounts of present surface and ground water use (water supplies, irrigation, reservoirs, recreation, transportation, etc.) within the plant site and environs. All locations of present and planned potential future water usage within 50 miles of the plant where the water supplies may be contaminated by plant effluents should be identified and the population associated with each use point given. In addition, all population centers taking water from waterways between the plant and the ocean, or such lesser distance as the applicant can technically justify, should be tabulated (distance, uses, amounts, and population). Sources which are river bank wells should be tabulated separately with their associated populations. The effect of consumptive water uses by the plant on the supplies or vice versa should be identified.

2.2 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 nuclear power plant 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,[7] (c) the species affects the well-being of some important species within criteria (a) or (b), or (d) the species is critical to the structure and function of the ecological system or is a biological indicator of radionuclides in the environment.

[7] In the writing and reviewing 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. New terminology defining "endangered or threatened with endangerment" has been promulgated in Pub. Law 93-205, 87 Stat. 884.

The initial inventory should establish the identity of the majority of terrestrial and aquatic organisms on or near the site and their relative (qualitative) abundances. The applicant should identify the "important" species from this list and discuss in detail their quantitative abundances. The discussion should include species that migrate through the area or use it for breeding grounds. The applicant should provide data on the count and distribution of important domestic fauna, in particular cows and goats, that may be involved in the radiological exposure of man via the iodine-milk route. A map that shows the distribution of the principal plant communities should be provided.

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

Identify any definable preexisting environmental stresses from sources such as pollutants, as well as any ecological conditions suggestive of such stresses. Describe the status of ecological succession. Discuss the histories of any infestations, epidemics, or catastrophes (caused by natural phenomena) that have had a significant impact on regional biota.

Ambient noise data acquired in communities surrounding the proposed site should be reported, where appropriate.

The information should be presented in two separate subsections, the first entitled "Terrestrial ecology" and the second, "Aquatic ecology." The sources of information should be identified. As part of this identification, present a list of any published material dealing with the ecology of the region. Locate and describe any ecological or biological studies of the site or its environs now in progress.

2.3 Meteorology[8]

The following data on site meteorology should be presented: (a) diurnal and monthly averages and extremes of temperature, dewpoint, and humidity; (b) monthly wind characteristics and all height(s) at which wind characteristics data are applicable or have been measured, including speeds and directions and their frequencies and joint frequencies of wind speed, stability category, and wind direction; (c) precipitation; and (d) frequency of occurrence and effects of storms accompanied by high-velocity winds including tornadoes and hurricanes. In item (b), the joint wind speed-stability-direction frequencies should be given as fractions when using 5-year National Weather Service (formerly U.S. Weather Bureau) summaries or as the number of occurrences when using only one or two years of onsite data. The data should be presented for each of the 16 cardinal compass directions, and the stability categories should be established to conform as closely as possible to those of Pasquill. Guidance on acceptable onsite meteorological measurements and data format is presented in Regulatory Guide 1.23.

Coverage should also include a discussion of climatology, existing levels of air pollution and their effects on plant operations, the relationship of the meteorological data gathered onsite to the data gathered on a regional basis, and the impact of the local terrain and large lakes and other bodies of water on meteorological conditions in the area. Attention should be directed to the meteorological situation on a regional basis.

At the time of construction permit application, applicants proposing a wet, dry, or wet-dry cooling tower for main condenser cooling or service water cooling should furnish appropriate summaries of joint humidity data along with the joint wind speed, stability category, and wind direction frequencies for heights related to the estimation of cooling tower moisture dispersion for at least six months and preferably one annual cycle in order to provide a basis for the estimation of the impact of tower operation on the environment. If the applicant does not have the detailed site-specific meteorological data described above, he may present information applicable to the general site area from the National Weather Service (formerly the U.S. Weather Bureau) or other authoritative source. The detailed site-specific data may be scheduled in accordance with Section 5, "General Considerations Related to Environmental Reports," of the Introduction of this guide.

2.4 Hydrology[9]

The effects of plant construction and operation on adjacent surface and ground waters are of prime importance. The applicant should describe, in quantitative terms, their physical, chemical, biological, and hydrological characteristics, their typical seasonal ranges and averages, and their historical lows and highs. The hydrological parameters include temperature, flow rate, stage or water level, ground water table altitude above mean sea level, chemical or saline stratification, tides, floods, currents, wave action, flushing times, and, if significant to the establishment of a long-term water supply, a forecast of other competing uses for water available from framework studies of the appropriate basin commission or planning agency having purview.

[8] Data for this section may be drawn from information in Section 2.3 of the "Preliminary Safety Analysis Report" as appropriate.

[9] Data for this section may be drawn from information in Section 2.4 of the "Preliminary Safety Analysis Report" as appropriate.

This information should be provided only for those waters that may affect plant effluents and plant water supply or that may be reasonably assumed to be affected by the construction or operation of the plant. For those water bodies and systems that may receive radionuclides from the plant, the data should be supplied out to a radius of 50 miles from the site.

Include a description of significant tributaries above and below the site and the pattern and gradients of drainage in the area. Where pollution exists, the applicant should identify, to the extent possible, the source of the pollutants, the nature of the pollutants (e.g., chemical species, physical characteristics such as color, temperature, etc.), the range of concentrations involved, and the time variations in release, if any. Note that information relating to water characteristics should include measurements, to the extent possible, made on or in close proximity to the site.

For all plant systems proposing once-through cooling, the relevant monthly maxima, minima, and averages of flow and water quality, based on not less than 10 years of record and preferably 25 years or longer, should be presented for the water bodies that may be affected by construction or operation of the plant. Supplemental data should be supplied for site-specific reaches of receiving water that relate to each other the current speed and direction, tidal stage or water surface elevations, or other periodic changes. These data, to be collected by onsite measurement wherever possible, are necessary to develop a systematic evaluation of the interaction of the proposed releases with the receiving water and to permit establishment of distributional isopleths of temperature or chemical and radioactive contaminants as detailed in Chapter 5 of this guide.

For systems involving forms of water storage, the surface areas, flow rates (in and out), evaporation, drawdown, percolation, evapotranspiration, and net volumes should be provided. The applicant should provide data concerning any drawdown of ground water caused by withdrawals from neighboring major industrial and municipal wells and how they may result in the transport of material from the site to these or other wells.

The manner in which volumes and areas of affected water bodies change with expected seasonal and other level fluctuations should be included. Monthly values of these parameters should be presented as a minimum; daily or shorter increments should be provided where they are important in determining the basis for evaluation of environmental effects. Where a stream or other water body is to be used by the plant in any way, the observed or estimated 7-day, once-in-ten-years low flow should be presented in addition to observed minimums. Additionally, the period-of-record drought flow sequence, transposed to the plant intake, should be provided where water supply availability may be questionable.

Vertical and areal variations of affected water bodies should be established in the vicinity of the site as a basis for evaluating any proposed mixing zones.

Where features of a proposed plant such as foundations, excavations, artificial lakes, and canals create artificial conduits for flow of groundwaters between and among aquifers, the applicant should furnish sufficient site-specific detail to justify his evaluation of the effects of construction and operation of the plant on established groundwater tables and usage. (Note that water use at the site is discussed in Subsection 2.1.4.)

2.5 Geology

A description of the major geological aspects of the site and its immediate environs should be provided. The level of detail presented should be appropriate to the proposed plant design and particularly the heat dissipation system planned. For example, if holding or cooling ponds are to be created, a detailed description of soil and bedrock types, etc. should be provided. Except for those specific features that are relevant to the environmental impact assessment, the discussion may be limited to noting the broad features and general characteristics of the site and environs (topography, stratigraphy, and soil and rock types).

2.6 Regional Historic, Scenic, Cultural, and Natural Features

Areas valued for their historic, scenic, cultural, or natural significance may be affected. The environmental report should include a brief discussion of the historic, scenic, cultural, and natural significance, if any, of the plant site and nearby areas with specific attention to the sites and areas listed in the "National Register of Historic Places" and the "National Registry of Natural Landmarks."

The "National Register of Historic Places" is published annually in the *Federal Register*; additions are published in the *Federal Register* on the first Tuesday of each month. The "National Registry of Natural Landmarks" appears in 37 FR 1496. Further guidance can be obtained from the National Park Service publication, "Preparation of Environmental Statements: Guidelines for Discussion of Cultural (Historic, Archeological, Architectural) Resources," August 1973.[10]

Also, the applicant should discuss his consultation with the appropriate State Liaison Officer for Historic Preservation concerning properties under consideration for nomination to the "National Register of Historic Places." The environmental report should contain evidence of contact with the Historic Preservation Officer for the state involved, including a copy of his comments concerning the effect of the undertaking on historic, archeological, and cultural resources. Procedures for the protection of historic and cultural properties (36 CFR Part 800) were published in 39 FR 3366 (Jan. 25,

[10] Copies may be obtained from Chief Historian, Room 1226, National Park Service, 18th and C Streets NW, Washington, D.C. 20240.

1974). It should also be indicated whether or not the site has any archeological significance and how this conclusion was reached. If such significance or value is present, the applicant's plans to ensure its preservation or plans of or filed in a public agency for this purpose should be described. In addition, the applicant should provide an assessment of the visual effects of the plant and transmission lines on nearby valued cultural, scenic, historic, park, and recreation areas. The assessment should include drawings or modified photographs indicating the plant facilities and their surroundings if visible from these nearby important vantage points and estimates of the number of people affected.

It should be stated whether the proposed transmission line right-of-way from the plant to the hookup with the existing system (Section 3.9) will pass through or near any area or location of known historic, scenic, cultural, natural, or archeological significance.

CHAPTER 3

THE PLANT

The operating plant and transmission system should be described in this chapter. Since environmental effects are of primary concern in the report, the plant effluents and plant-related systems that interact with the environment should be described in particular detail.

3.1 External Appearance

The building layout and plant perimeter should be illustrated and related to the site maps presented in Section 2.1. The plant profile should be shown to scale by line drawings or other illustrative techniques. A recent oblique aerial photograph or graphic representation of the completed station should be included.

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.

The location and elevation of release points for liquid and gaseous wastes should be clearly indicated by a system of (x,y) coordinates related to the centerline of containment of the first nuclear unit covered by this proposal.

3.2 Reactor and Steam-Electric System

The reactor type (BWR, PWR, HTGR, etc.), manufacturer, architect-engineer, number of units, and kind (make) of turbine generator should be stated. The fuel (cladding, enrichment, etc.) should be described. Rated (license level) and design ("stretch" level) electrical and thermal power of the reactor, as well as the in-plant electrical power consumption, should be given.

The relationship of plant heat rate to the expected variation of turbine back pressure for 100%, 80%, and 60% unit load should be furnished for design circulator flow, and ranges of operational variation should be given.

3.3 Plant Water Use

A quantitative water-use diagram for the plant showing maximum and average water flows to and from the various plant water systems (heat dissipation system, sanitary system, radwaste and chemical waste systems, process water system, etc.) should be presented. The sources of the water for each input should be described. The maximum and average consumptive use of water by the plant should be shown. The above data which quantify plant water use should be tabulated for various plant conditions including maximum power operation, minimum anticipated power operation, and temporary shutdown, with and without cooling towers and cooling ponds (if seasonal usage is planned). To avoid excessive detail on the diagram, refer to other sections (e.g., Sections 3.4, 3.5, 3.6, and 3.7) for relevant data.

The station usage above should be compared with the low-flow (drought) periods of record on rivers or variable lakes. Based on historical low-flow records, provide the estimated frequency and duration of station outages and emergency systems usage resulting from insufficient supply of operational cooling water. If onsite reservoirs are to be created, describe level fluctuations and the consequences of such fluctuations on such environmental factors as vegetation, aquatic food chains, and insect breeding.

3.4 Heat Dissipation System

Heat-removal facilities for normal operation should be discussed in detail. Process flow diagrams and scale drawings of intake and outfall structures should be presented. The reasons for providing the particular facilities (such as water resources limitations or reduction of thermal effects) should be noted. The source of the cooling water should be identified. (Its natural temperature, including monthly changes and stratification, should be described in Section 2.4.)

Topics to be covered include quantity of heat dissipated; quantity of water withdrawn; consumptive use, return, design, size, and location of cooling towers, cooling lakes, or spray ponds; air and water flow rates, pertinent temperatures, estimates of quantity of drift and drizzle (and methods used in making estimates) for cooling towers; blowdown volume, rate of discharge, and physical and chemical characteristics for towers and ponds; temperature changes, rate of changes, and holdup times in cooling ponds or artificial lakes; rate of evaporation of water (by months) from towers, ponds, lakes, or other related cooling facilities; information on dams or dikes where a cooling reservoir is created to include essential features of the interior hydrodynamics; design and location of water intake systems or structures, including numbers, types, and sizes of screens, water depth, and flow and velocity at design conditions and for any anticipated conditions of reduced circulator flow; number and capacity of pumps at intake structure; temperature differences between withdrawn and returned water, including consideration of operational variation of circulator flow; time of travel across condenser and to the end of contained discharge lines, canals, etc. for different months and flows; point of addition and flow rate of any diluent added to the cooling water stream; and details of outfall design, including discharge flow and velocity and the depth of the discharge structure in the receiving water. Descriptions should include operational modes of important subsystems. Ranges of operating conditions involving special conditions, such as operating with reduced circulator flow, should be described.

Procedures and schedules for removal and disposal of blowdown, of slimes and algal growth in the system, and of trash collected at the intake structures should be described. Data on relevant chemical constituents should be presented in Section 3.6.

Seasonal and operational variations in all discharges should be described. This should include deicing, backflushing, and pump maintenance downtime under worst-case operating conditions.

3.5 Radwaste Systems and Source Term

Provide the radioactive source term and describe the liquid, gaseous, and solid radioactive waste (radwaste) treatment systems. Show the origin, treatment, and disposal of all liquid, gaseous, and solid radioactive waste generated by the plant under normal operation and anticipated operational occurrences. Show the instrumentation provided to monitor all effluent release points.

3.5.1 Source Term

Provide the sources of radioactivity which serve as input to the liquid, gaseous, and solid radioactive waste treatment systems for normal operation and anticipated operational occurrences. Describe the calculational model used to determine the specific activity of each radioisotope in the primary and secondary (PWR) coolant. The fraction of fuel releasing radioactivity into the primary coolant or the fission product noble gas release rate used as a design basis should be consistent with operating experience.

Provide a complete derivation of the concentrations of activated corrosion products used in the source term calculations. Provide the bases for all assumptions used in the derivation. The activation of water and constituents normally found in the reactor coolant system should also be taken into account. Identify sources of isotopes (e.g., N-16, Ar-41), together with the concentration of each isotope.

To meet the requirements of this section regarding calculational models and parameters used to derive source terms for normal operation and anticipated operational occurrences, reference may be made to appropriate sections of the SAR and to information supplied in response to Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."

Identify sources of tritium in the reactor coolant. Describe the management of tritiated liquids during normal operations and anticipated operational occurrences. Identify release points for tritiated liquids and gases and the quantity of tritium (curies) expected to be released annually by each pathway. Describe special provisions incorporated in the plant design to reduce airborne tritium concentrations in the containment and the fuel pool area during refueling.

Calculate the concentration of radioactive materials in the fuel pool and describe provisions to purify the fuel pool water. Provide the source term for radioactive materials in gaseous effluents evaporating from the fuel pool. Provide the bases for the values used. Cite pertinent operating experience.

For purposes of evaluating the effluent from the various ventilation systems, provide estimates of the leakage rates from the reactor coolant system and other fluid systems containing radioactivity into buildings and areas serviced by the ventilation systems. Tabulate the sources of leakage and estimate their contribution to the total quantity. Provide estimates of the releases of radioactive gases and radioiodines from each leakage source and describe their subsequent transport and release path. Provide the bases for the values used. Cite previous pertinent experience from operating reactors. Discuss leakage measurements and special design features to reduce leakage.

Identify all sources of potential effluent releases of radioactive material that are not normally considered part of the radioactive waste management systems, e.g., the steam generator blowdown system, building ventilation exhaust systems, containment purging, and the turbine gland seal system. Provide estimates of the release of radioactive materials (by radionuclide) from each source identified and describe the subsequent transport mechanism and release path. Identify planned operations and anticipated operational occurrences that may result in release of radioactive materials to the environment. Consider leakage rates and concentrations of radioactive materials for both expected and design conditions. Provide the bases for all values used. Identify parameters that differ from those specified in Draft Regulatory Guides[11] entitled "Calculations of Releases of Radioactive Materials in Liquid and Gaseous Effluents from Pressurized Water Reactors (PWRs)" and "Calculation of Releases of Radioactive Materials in Liquid and Gaseous Effluents from Boiling Water Reactors (BWRs)." Differences in parameters should be justified. Describe changes from previous designs that may affect the release of radioactive materials to the environment.

Provide answers to the source term questionnaires which appear as Appendices 2 and 3 of this guide.

3.5.2 Liquid Radwaste 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

[11] These two guides were published in "Attachment to Concluding Statement of Position of the Regulatory Staff, Public Rulemaking Hearing on: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low As Practicable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactors, Draft Regulatory Guides for Implementation," February 20, 1974. Docket No. RM-50-2. Available from U.S. Nuclear Regulatory Commission, Washington D.C. 20555, Attention: Director of Regulatory Standards.

occurrences. Provide piping and instrumentation schematic drawings (P&IDs) and flow diagrams for 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. Estimated quantities should be given in terms of gallons, total curie content, and activity concentration in μCi/ml.

Indicate which systems are used separately and which are shared with other units at the site, as appropriate. Provide a summary tabulation of all radionuclides that will be discharged with each effluent stream, and provide the expected annual average release rate. Data should be consistent with the recommendations for data in the Draft Regulatory Guides cited in Subsection 3.5.1.

3.5.3 Gaseous Radwaste Systems

Describe the gaseous radwaste systems and their capabilities to control, collect, process, handle, store, and dispose of gaseous radioactive wastes generated as the result of normal operation and anticipated operational occurrences. Include ventilation systems that potentially exhaust radioactive materials to the environment. Indicate systems that incorporate high-efficiency particulate air filters and/or charcoal adsorbers in the treatment of building effluents. Provide P&IDs 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, expected decontamination factors, and holdup times. Estimated quantities should be given in terms of cubic feet, total curie content, and activity concentration in μCi/cc.

Indicate which systems are used continuously and which are operated only under specific circumstances. Indicate those systems that are shared between separate buildings and also those that share a common effluent release point. Identify all gaseous radioactive effluent release points including heights above station grade.

3.5.4 Solid Radwaste System

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

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

Provide P&IDs and flow diagrams showing the origin, treatment, storage, and shipment provisions for all solid radwaste generated by the plant under consideration. Show system and component capacities. Identify the normal mode of operation.

3.5.5 Process and Effluent Monitoring

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

3.6 Chemical and Biocide Wastes

The applicant should describe normal and expected maximum discharges of chemical additives (including corrosion inhibitors, chemical and biological antifouling agents, and cleaning compounds), corrosion products, waste streams or discharges from drains, laundry waste systems which may also contain radionuclides, and other streams that may enter the local environment as a result of plant operation. Maximum and average concentrations of chemicals and solids in any brines or cooling system effluents should be given. Quantities of chemicals discharged with treated or partially treated waste streams not covered by 40 CFR Part 423, "Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category," issued by the Environmental Protection Agency should be specifically listed.

Ground deposition and airborne concentrations of chemicals and solids entrained in spray fallout should be estimated and the methods and bases for the estimates stated.

The discussion should include a description of procedures by which all effluents will be treated, controlled, and discharged to meet EPA effluent guidelines and standards of performance. The expected nominal and maximum concentrations for each permitted discharge and the quantities that will be discharged each year should be given. Seasonal and operational variations in discharges should be described as they relate to effluent limitations and standards of performance. A flow diagram (which may also be combined with the liquid radwaste system flow diagram) should be included.

3.7 Sanitary and Other Waste Systems

The applicant should describe any other nonradioactive solid or liquid waste materials such as sanitary and occurrences. Provide piping and instrumentation schematic drawings (P&IDs) and flow diagrams for 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. Estimated quantities should be given in terms of gallons, total curie content, and activity concentration in μCi/ml.

Indicate which systems are used separately and which are shared with other units at the site, as appropriate. Provide a summary tabulation of all radionuclides that will be discharged with each effluent stream, and provide the expected annual average release rate. Data should be consistent with the recommendations for data in the Draft Regulatory Guides cited in Subsection 3.5.1.

3.5.3 Gaseous Radwaste Systems

Describe the gaseous radwaste systems and their capabilities to control, collect, process, handle, store, and dispose of gaseous radioactive wastes generated as the result of normal operation and anticipated operational occurrences. Include ventilation systems that potentially exhaust radioactive materials to the environment. Indicate systems that incorporate high-efficiency particulate air filters and/or charcoal adsorbers in the treatment of building effluents. Provide P&IDs 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, expected decontamination factors, and holdup times. Estimated quantities should be given in terms of cubic feet, total curie content, and activity concentration in μCi/cc.

Indicate which systems are used continuously and which are operated only under specific circumstances. Indicate those systems that are shared between separate buildings and also those that share a common effluent release point. Identify all gaseous radioactive effluent release points including heights above station grade.

3.5.4 Solid Radwaste System

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

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

Provide P&IDs and flow diagrams showing the origin, treatment, storage, and shipment provisions for all solid radwaste generated by the plant under consideration. Show system and component capacities. Identify the normal mode of operation.

3.5.5 Process and Effluent Monitoring

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

3.6 Chemical and Biocide Wastes

The applicant should describe normal and expected maximum discharges of chemical additives (including corrosion inhibitors, chemical and biological antifouling agents, and cleaning compounds), corrosion products, waste streams or discharges from drains, laundry waste systems which may also contain radionuclides, and other streams that may enter the local environment as a result of plant operation. Maximum and average concentrations of chemicals and solids in any brines or cooling system effluents should be given. Quantities of chemicals discharged with treated or partially treated waste streams not covered by 40 CFR Part 423, "Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category," issued by the Environmental Protection Agency should be specifically listed.

Ground deposition and airborne concentrations of chemicals and solids entrained in spray fallout should be estimated and the methods and bases for the estimates stated.

The discussion should include a description of procedures by which all effluents will be treated, controlled, and discharged to meet EPA effluent guidelines and standards of performance. The expected nominal and maximum concentrations for each permitted discharge and the quantities that will be discharged each year should be given. Seasonal and operational variations in discharges should be described as they relate to effluent limitations and standards of performance. A flow diagram (which may also be combined with the liquid radwaste system flow diagram) should be included.

3.7 Sanitary and Other Waste Systems

The applicant should describe any other nonradioactive solid or liquid waste materials such as sanitary and chemical laboratory wastes, laundry solutions, and decontamination solutions that may be created during plant operation. The description should include estimates of the quantities of wastes to be disposed of, their pollutant concentrations, 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 effluent limitations and standards of performance under FWPCA should be described.

The applicant should describe any other gaseous effluents (e.g., from diesel engines, gas turbines, heating plants, incinerators) created during plant operation, should estimate the frequency of release and describe how they will be treated before release to the environment, and should estimate the total quantity of SO_2 and NO_X pollutants to be discharged annually.

3.8 Reporting of Radioactive Material Movement

The transportation of radioactive materials may have environmental effects. In this section, the radioactive materials to be transported to and from the site should be described.

A description of the type of fresh fuel to be used and the quantity of fresh and irradiated fuel to be shipped to and from the site each year should be provided. The form of fuel, enrichment, cladding, total weight per shipment, expected form of packaging, and the estimated number of shipments per year should be discussed.

The applicant should estimate the weight of irradiated fuel to be shipped from the site each year, the number of shipments per year, the average and maximum burnup for each shipment, the cooling time required prior to each shipment, and the form of packaging expected to be used.

Estimates of the annual weight, volume, and activity of radioactive waste materials (e.g., spent resins and air filters) to be shipped from the site should be provided. The applicant should categorize the wastes according to whether they are liquid, solid, or gaseous. Any processing required before shipment, such as compacting or consolidating with vermiculite and cement, should be described.

The applicant should provide a table of the principal shipment categories, the types of transportation systems to be employed, and the estimated vehicle miles for each category and transport mode for the first five full years of commercial operation following activation of the first unit of a station.

The information supplied by the applicant will be used by the Commission to estimate (per trip and per year) the radiological dosages, if any, to drivers, helpers, and population along the transport route for fresh fuel, irradiated fuel, and radioactive wastes.[12]

3.9 Transmission Facilities

The environmental report should contain sufficient information to permit evaluation of the environmental impact of transmission lines and related facilities that are to be constructed between the proposed nuclear installation and an interconnecting point or points on the existing high-voltage transmission system or are required elsewhere in the system for stability or power distribution purposes directly related to the proposed nuclear installation. For material useful in preparing this subsection, the applicant is advised to consult the Department of Interior/Department of Agriculture publication, "Environmental Criteria for Electric Transmission Systems;" the Federal Power Commission publication, "Electric Power Transmission and the Environment;" the Electric Power Research Institute (EPRI) book, "Transmission Line Reference Book, 345KV and Above," (scheduled publication date, late 1974);[13] and the National Electric Safety Code.

Adequate descriptions of proposed line-related facilities, such as substations, should be included in the report. Sufficient information should be provided on the external appearance of the transmission structures to permit an assessment of their aesthetic impact.

This portion of the report should describe the proposed transmission system and include basic design parameters such as voltage, capacity under normal and emergency load conditions, conductor type and configuration, ruling spans, and electrical clearances. Illustrate the type of structures, provide profile drawings of the conductors and structures to be located in highly visible areas, and indicate the dimensions, materials, color, and finish.

The applicant should supply contour maps and/or aerial photographs showing the proposed rights-of-way and identifying substations or other points at which the transmission lines will connect with the existing high-voltage system. 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 transmission lines and indicate the present and expected

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[12] A general analysis of the environmental impact of transporting radioactive materials to and from a light-water-cooled nuclear power reactor has been issued by the Commission. See "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, Directorate of Regulatory Standards, USAEC, December 1972, and 38 FR 3334, Feb. 5, 1973. Copies of WASH-1238 may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

[13] Copies can be obtained from Fred Weidner and Son, Printers, 421 Hudson St., New York 10014, when published.

usage of such land. Any area where construction of the transmission 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 transmission lines will be placed underground. Indicate where highways, railways, water bodies, and areas of archeological, historical, and recreational interest will be crossed. Where transmission lines offer potential hazard to aerial navigation, appropriate FAA standards should be referenced.

Identify alternative rights-of-way and terminal locations considered, and provide a brief discussion of the rationale for the selection of the proposed rights-of-way. Provide sufficient information (including selection criteria) for assessment of the alternatives.

This portion of the report should identify and evaluate parameters of possible environmental significance, including radiated electrical and acoustic noise, induced or conducted ground currents, corona effects, and ozone production, and what mitigating actions will be taken to minimize these effects.[14] Appropriate State and Federal standards should be referenced as applicable.

[14] Details of the controls and effects are requested in Section 5.5.

CHAPTER 4

ENVIRONMENTAL EFFECTS OF SITE PREPARATION, PLANT CONSTRUCTION, AND TRANSMISSION FACILITIES CONSTRUCTION

This chapter of the applicant's environmental report should discuss the expected effects of site preparation and plant and transmission facilities construction. The effects should be presented in terms of their physical impact on the resources and populations described in Chapter 2. Means selected by the applicant to measure and minimize related environmental effects should be outlined. Effects that are primarily economic or social in character should be discussed in Chapter 8.

The preparation of the site and the construction of a nuclear power plant and related facilities will inevitably affect the environment; some of the effects will be adverse and some will be beneficial. Effects are considered adverse if environmental change or stress causes some biotic population or natural resource to be less safe, less healthy, less abundant, less productive, or less aesthetically or culturally pleasing, as applicable; if the change or stress reduces the diversity and variety of individual choice, the standard of living, or the extent of sharing of life's amenities; or if the change or stress tends to lower the quality of renewable resources or to impair the recycling of depletable resources. Effects are considered beneficial if they cause changes or stresses having consequences opposite to those just enumerated.

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 regarded as unavoidable and irreversible. Those effects that represent an irretrievable commitment of resources should receive detailed consideration in Section 4.3. (In the context of this discussion, "irretrievable commitment of resources" alludes to natural resources and means a permanent impairment of these, e.g., loss of wildlife habitat; destruction of nesting, breeding, or nursing areas; interference with migratory routes; loss of valuable or aesthetically treasured natural areas as well as expenditure of directly utilized resources.)

4.1 Site Preparation and Plant Construction

The applicant should organize the discussion in terms of the effects of site preparation and plant construction on both land use and water use. The consequences to both human and wildlife populations should be considered and identified as unavoidable, reversible, etc. according to the categorization set forth earlier in this chapter.

In the land use discussion, describe how construction activities may disturb the existing terrain and wildlife habitats. Consider the effects of such activities as creating building material supply areas; building temporary or permanent roads, bridges, and service lines; disposing of trash and chemical wastes (including oil); excavating; and land filling. Provide information bearing on such questions as: How much land will be torn up? For how long? Will there be dust or smoke problems? What explosives will be used? Where and how often? Indicate the proximity of human populations. Identify undesirable impacts on their environment arising from noise and from inconvenience due to the movement of men, material, and machines, including activities associated with any provision of housing, transportation, and educational facilities for workers and their families. The site activities that are planned for initiation prior to receipt of a construction permit and those that would be performed in the event the applicant is granted a limited work authorization (10 CFR Part 50, §50.10(e), April 24, 1974) should be described. This description should include the schedule for the start and finish of each activity.

An annual schedule of the estimated work force to be involved in site preparation and plant construction should be presented. Describe any expected changes in accessibility of historical, cultural,[15] and archeological sites and natural landmarks in the region.

The discussion should also include any effects of site preparation and plant construction activities whose consequences may be beneficial to the region, as, for example, the use of spoil to create playgrounds and/or recreational facilities.

The discussion of water use should describe the impact of site preparation and construction activities on regional water (lakes, streams, ground water, etc.). The overall plan for protection of water bodies (recreation, reservoir, etc.) that may be affected by plant construction should be discussed. Activities that might affect water use include the construction of cofferdams and storm sewers, dredging operations, placement of fill material in the water, and the creation of shoreside facilities involving bulkheads, piers, jetties, basins, or other structures allowing ingress to or egress from the plant by water. Examples of other pertinent activities are the construction of intake and discharge structures for cooling water or other purposes, straightening or deepening of a water channel, operations affecting water levels (flooding), construction, dewatering effects on nearby ground water users, etc. The applicant should describe the effects of these activities on navigation, fish and wildlife resources, water quality, water supply, aesthetics, etc., as applicable.

Where it is proposed to create a cooling water lake, describe the effects on the local ecology, including the

[15] Depending on location, the construction of a nuclear power station and associated access roads, docks, 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 his 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.

loss of flora and local migration of fauna from the area the lake will occupy. In addition, the expected establishment and development of aquatic plant and animal life should be described. This discussion may reference any available data based on studies of similarly sited artificial lakes.

4.2 Transmission Facilities Construction

The effects of clearing the right-of-way and installing transmission line towers and conductors on the environs and on the people living in or traveling through the adjacent area should be discussed in this section. (Refer to Section 3.9 for the basic information.)

The following topics may serve as guidelines for this discussion, but the applicant should include any additional relevant material.

1. The proposed techniques for clearing the right-of-way and any resulting temporary and permanent changes that will be induced in the physical and biological processes of plant and wildlife through changes in the hydrology, topography, or ground cover or the use of growth retardants, chemicals, biocides, sprays, etc. during construction and installation of the transmission lines.
2. The methods to be used for erecting the transmission line structures and for stringing conductors, including related environmental effects.
3. Number and length of new access and service roads required.
4. Erosion directly traceable to construction activities.
5. Loss of agricultural productivity and other present uses of right-of-way.

Briefly discuss the effects of construction on any identified endangered species (as defined in Section 2.2).

4.3 Resources Committed

Discuss any irreversible and irretrievable commitments of resources (loss of land, water, nonrecyclable building materials, destruction of biota, etc.) which are expected if site preparation and construction of plant and transmission facilities proceed. Such losses should be evaluated in terms of their relative and long-term net and absolute impacts. (See Section 5.7 of this guide for more detailed consideration.)

4.4 Radioactivity

For multiunit stations, provide the estimated annual doses at various locations in a new unit construction area from onsite radiation sources such as the turbine systems (for BWRs), the auxiliary building, the reactor building, and stored radioactive wastes and from radioactive effluents (direct radiation from the gaseous radioactive plume, etc.). Provide estimated annual doses to construction workers due to radiation from these sources from the adjacent operating unit(s) and the annual man-rem doses associated with such construction. Include models, assumptions, and input data. If the "Safety Analysis Report" (SAR) has already been submitted or will be submitted simultaneously with the applicant's ER, reference may be made to the analysis contained in the SAR.

4.5 Construction Impact Control Program[16]

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

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

Precautions for handling of fuels, lubricants, oily wastes, and other chemical waste should be included. Describe procedures for disposal of slash and unmerchantable timber and for cleanup and restoration of areas affected by clearing and construction activities.

Describe any other measures planned for the protection of fish and wildlife during construction.

[16]Applicants are encouraged to make use of "General Environmental Guidelines for Evaluating and Reporting the Effects of Nuclear Power Plant Site Preparation, Plant and Transmission Facilities Construction" (published February 1974) as interim guidance. Copies may be obtained from the Atomic Industrial Forum, Inc., 475 Park Avenue South, New York, N.Y. 10016.

CHAPTER 5
ENVIRONMENTAL EFFECTS OF PLANT OPERATION

This chapter should describe the interaction of the plant and transmission facilities (discussed in Chapter 3) and the environment (discussed in Chapter 2). To the extent possible, the applicant should avoid repeating the material presented in Chapters 2 and 3. Measures planned to reduce any undesirable effects of plant operation (including the transmission facilities) on the environment should be described in detail. In the discussion of environmental effects, as in Chapter 4, effects that are considered unavoidable but either inherently temporary or subject to later amelioration should be clearly distinguished from those regarded as unavoidable and irreversible. Those effects that represent an irretrievable commitment of resources should receive detailed consideration in Section 5.7.

The impacts of operation of the proposed facility should be, to the fullest extent practicable, quantified and systematically presented.[17] 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–the plant subsystem, waste effluent–and the population or resource affected should be made clear in each case. The impacts should be distinguished in terms of their effects on surface water bodies, ground water, air, and land.

Finally, the applicant should discuss the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity. As used in this guide, "short term" may be taken to refer to the operating life of the proposed facility and "long term" to time periods extending beyond this life. The applicant should assess the action for cumulative and projected long-term effects from the point of view that each generation is trustee of the environment for each succeeding generation. This means considering, for example, the commitment of a water source to use as a cooling medium in terms of impairment of other actual or potential uses, and any other long-term effects to which the operation of this facility may contribute.

5.1 Effects of Operation of Heat Dissipation System

Waste heat dissipated by the system described in Section 3.4 alters the thermal conditions of the environment. Since the heat transfer is usually effected through the surface of a river, pond, lake, estuary, or ocean or by the evaporation of water in a cooling tower, the meteorology and hydrology of the environment (Sections 2.3 and 2.4) and the aquatic ecology (Section 2.2) are of primary importance in determining what effects the released heat will have on the aquatic environment.

5.1.1 Effluent Limitations and Water Quality Standards

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

5.1.2 Physical Effects

Describe the effect that any heated effluent, including service water or closed-cycle system blowdown, will have on the temperature of the receiving body of water with respect to space and time. Describe changes in temperature caused by drawing water from one depth and discharging it at another. The predicted characteristics of the mixing zone and temperature changes in the receiving body of water as a whole should be covered. Include seasonal effects. Discuss any model studies and calculations that have been performed to determine these characteristics, giving references to reports that provide supporting details. Details of calculational methods used in predicting thermal plume configurations should be given in an appendix to the report. The results should be portrayed in graphic form, showing isotherms in three dimensions for a range of conditions which form the basis for the estimation of ecological impact.

Where releases are determined to be affected by tides and winds, a probability rose relating directions, extent of modification, and time should be included. Both a daily and an annual probability rose should be developed where tides are operative.

5.1.3 Biological Effects

Describe the effects of released heat on marine and freshwater life. Give the basis for the prediction of effects. In this discussion, appropriate references to the baseline ecological data presented in Section 2.2 should be made. Expected thermal effects should be related to the optimum and tolerance temperature ranges for important aquatic species (as defined in Section 2.2) and the food base which supports them. The evaluation should consider not only the mixing zone, but also the entire regional aquatic habitat potentially affected by operation of the proposed plant.

[17] Quantification of environmental costs is discussed in Chapter 10.

Potential hazards of the cooling water intake and discharge structures (described in Section 3.4) to fish species and food base organisms should be identified, and steps planned to measure and minimize the hazards should be discussed. Diversion techniques should be discussed in the light of information obtained from ecological studies on fish population, size, and habitats.

The effects of passage through the condenser on zooplankton, phytoplankton, meroplankton, and small nektonic forms such as immature fish and the resultant implications for the important species and functional groups should be discussed.

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

Plant-induced changes in the temperature of the discharged water subsequent to environmental stabilization can affect aquatic life in the receiving body. Accordingly, the applicant should discuss the possible effects of reactor shutdown (and other temporary related conditions), including the dependence of effects on the season in which shutdown occurs. An estimate of the number of scheduled and unscheduled shutdowns per year should be given. Refueling schedules should be indicated, particularly where the rate and magnitude of temperature change in the receiving waters are likely to be large (e.g., as a result of refueling in winter). Describe procedures for reducing thermal shock to aquatic organisms during shutdown or refueling. A discussion of operation with reduced circulator flow or increased temperature differentials should be specifically addressed to timing and extent to provide a basis for comparison of the effects of such operation with those of standard operating modes.

5.1.4 Effects of Heat Dissipation Facilities

Discuss the expected effects of heat dissipation facilities such as cooling towers, lakes, spray ponds, or diffusers on the local environment and on agriculture, housing, highway safety, recreation, air and water traffic, airports, or other installations with respect to meteorological phenomena, including fog, icing, precipitation modification, humidity changes, cooling tower blowdown and drift, and noise. Where cooling towers are considered either as a design basis or as an alternative, the discussion should include estimates of the dimensions of the visible plume under various stability classes (Pasquill) and the probability distribution of wind directions, air temperature, and humidity expected at the site. If fog clouds or icing may occur, the estimated hours per year, distances, and directions should be presented, along with transportation arteries (including navigable waters) potentially affected and measures to mitigate such effects. Consider possible synergistic effects that might result from mixing of fog or drift with other effluents in the atmosphere. (Environmental effects of chemicals discharged from cooling tower blowdown and drift should be discussed in Section 5.3.)

In addition to the meteorological effects noted, other local environmental impacts may occur. These should be described. For example, if a cooling pond or lake is created or where ground water is a source of station water supply, the effects on ground water may be substantial; consequently, the alteration of water table levels, recharge rates, and soil permeability should be discussed.

5.2 Radiological Impact from Routine Operation

In this section, the applicant should consider impacts on man and on biota other than man attributable to the release of radioactive materials and to direct radiation from the facility. The biota to be considered are those species of local flora and local and migratory fauna defined as "important" in Section 2.2, and whose terrestrial and/or aquatic habitats provide the highest potential for radiation exposure. Estimates of the radiological impact on man via the most significant exposure pathways should be provided.

5.2.1 Exposure Pathways

The various possible pathways for radiation exposure of the important local flora and local and migratory fauna should be identified and described in the text and flowcharts. (An example of an exposure pathway chart for organisms other than man is given in Appendix 4.) The pathways should include the important routes of radionuclide translocation (including food chains leading to important species) to organisms or sites.

The various possible pathways for radiation exposure of man should be identified and described in text and flowcharts. (An example of an exposure pathway chart for man is given in Appendix 4.) As a minimum, the following pathways should be evaluated: external radiation from swimming, shoreline fishing (radionuclides deposited in sediments), immersion in airborne effluents, and radionuclides deposited on the ground surface and vegetation, and internal exposure from inhalation of airborne effluents and from ingestion of milk, drinking water, fish and game, invertebrates, and plants.

5.2.2 Radioactivity in Environment

In Section 3.5, the radionuclide concentrations in the liquid and gaseous effluents from the facility are listed. In this section, the applicant should consider how these effluents are quantitatively distributed in the environment. Specifically, estimates should be provided for the radionuclide concentration (a) in all waters that receive any liquid radioactive effluent, (b) on land areas, and (c) on vegetation (on a per unit area basis) in the environs.

If there are other components of the physical environment that may accumulate radioactivity and thus result in the exposure of living organisms to nuclear radiations, they should be identified and their radioactivity burden estimated. In addition, information concerning any cumulative buildup of radionuclides in the environment, such as in sediments, should be presented and discussed. Information concerning any relocation of contaminated or potentially contaminated materials in the physical environment, such as occurs in dredging operations, should be provided.

Estimate the expected annual average concentrations of radioactive nuclides (listed in Section 3.5) in receiving water at locations where water is consumed or otherwise used by human beings or where it is inhabited by biota of significance to human food chains. (If discharges are intermittent, concentration peaks as well as annual averages should be estimated.) Specify the dilution factors used in preparing the estimates and the locations where the dilution factors are applicable.

From meteorological data, estimate the dispersion parameters (χ/Q) at points of potential maximum concentration outside the site boundary and at points of potential actual maximum individual exposure. Assume meteorological conditions during releases which are consistent with expected periods of release. For example, assume annual average meteorological conditions for a BWR and limiting meteorological conditions for a PWR. Identify the locations of points of release (stack, roof vent, etc.) used in calculations. Provide estimates of the annual average χ/Q values for 16 radial sectors to a distance of 50 miles, using appropriate meteorological data.

A summary of data, assumptions, and models used in determining radioactivity concentrations and burdens should be provided. Guidance on atmospheric diffusion models is given in Regulatory Guide 1.42.

5.2.3 Dose Rate Estimates for Biota Other Than Man

From considerations of the exposure pathways and the distribution of facility-derived radioactivity in the environs, the applicant should estimate the maximum radionuclide concentrations that may be present in important local flora and local and migratory fauna and the internal dose rates (millirad/year) that may result from those concentrations. Values of bioaccumulation factors[18] used in preparing the estimates should be based on site-specific data if available; otherwise, values from the literature may be used. The applicant should tabulate and reference the values of bioaccumulation factors used in the calculations. Dose rates to important local flora and local and migratory fauna that receive the highest external exposures should be provided along with a description of the calculational models.

5.2.4 Dose Rate Estimates for Man

5.2.4.1 **Liquid Pathways.** Provide data on recreational and similar use of receiving water and its shoreline, e.g., swimming, fishing, picnicking, hunting, clam digging. Include any persons who spend the major part of their working time on the water adjacent to the site, and indicate the amount of time spent per year in this activity.

Data on irrigation usage of the receiving water should be included, such as the amount of water used, the number of acres irrigated, locations at which irrigation water is withdrawn (downstream from the site), types of crops produced on irrigated soils within 50 miles downstream of the site, and the yield per acre of each crop.

Where downstream users may ingest waters drawn from mixing zones or areas of limited dilution, provide data on means to provide temporary water supply from storage or alternative sources. Provide data on the commercial and recreational fish and seafood catch (number of pounds per year of each species within the region). Include any harvest and usage of seaweed or other aquatic plant life.

Determine the expected radionuclide concentrations in aquatic and terrestrial organisms significant to human food chains. Use the bioaccumulation factors given in Subsection 5.2.3, or supply others as necessary. If significant hunting occurs on land adjacent to or near the site of the nuclear plant and the flesh is eaten by the local populace, annual weight and radionuclide concentrations in such flesh should be estimated.

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

5.2.4.2 **Gaseous Pathways.** Estimate total body and significant organ doses (millirem/year) to individuals exposed at the point of maximum ground-level concentrations offsite.

Estimate dry and wet deposition of radioactive halogens and particulates on food crops and pasture grass. Consider also the effect of the type, frequency, and magnitude of precipitation in the area. Consider the maximum ground-level deposition on pasture grass, even though milk cows or goats may not be grazing there at the present time. Estimate the total body and thyroid doses (millirem/year) and significant doses received by

[18] The bioaccumulation factor is the equilibrium value of the ratio: (concentration in organism)/(concentration in water). Values of bioaccumulation factors can be obtained from such references as S.E. Thompson, C.A. Burton, D.J. Quinn, and Y.C. Ng, "Concentration Factors of Chemical Elements in Edible Aqueous Organisms," University of California, Lawrence Livermore Laboratory report UCRL-50564 (Rev. 1), October 1972 (revision of an identically titled document, dated December 30, 1968, by W.H. Chapman, H.L. Fisher, M.W. Pratt and A.M. Freke); and A.M. Freke, "A Model for the Approximate Calculation of Safe Rates of Discharge of Radioactive Wastes Into Marine Environments," Health Physics, Vol. 13, p. 734, 1967.

other organs via such potential pathways,[19] including direct radiation from surface-deposited radionuclides.

Provide an appendix describing the models used in these calculations.

5.2.4.3 Direct Radiation From Facility. The applicant should provide an estimate of the total external dose (millirem/year) received by individuals outside the facility from direct radiation, e.g., gamma radiation emitted by turbines and vessels for storage of radioactive waste. In particular, the applicant should estimate the expected external dose rates at the boundary of the exclusion area (as defined in Subsection 2.1.2 of this guide) and the dose rate at the most critical nearby houses, as well as schools, hospitals, or other publicly used facilities within one mile of the proposed nuclear unit(s). A summary of data, assumptions, and models used in the dose calculations should be given.

5.2.5 Summary of Annual Radiation Doses

The applicant should present a table that summarizes the estimated annual radiation dose to (1) onsite radiation workers and (2) the regional population (during commercial operation of the facility) from all plant-related sources, using values calculated in previous sections. The tabulation should include (a) the total of the whole-body doses to the population (man-rem/year) from all receiving-water-related pathways and (b) the total of the whole-body doses to the population (man-rem/year) attributable to gaseous effluents out to a distance of at least 50 miles from the site. This summary should reflect data inclusive of points of accumulation or concentration..

5.3 Effects of Chemical and Biocide Discharges

Chemical and biocide discharges are described in Section 3.6. Water resources and use are discussed in Sections 2.4 and 3.3. In this section, the specific concentrations of these wastes at the points of discharge should be compared with natural ambient concentrations, with allowable release concentrations under applicable effluent limitations (40 CFR Part 423), and with applicable water quality standards.

Dilution and mixing of discharges into the receiving waters should be discussed in detail, and estimates of concentrations at various distances from the point of discharge should be provided. Include a detailed description of the method of calculation. The estimated area in the receiving body of water enclosed by contours corresponding to water-quality-standard values should be given. Variation of concentrations with changes in condition (e.g., stream flow, temperature) of receiving water should be discussed. The effects on terrestrial and aquatic environments from oil or chemical wastes that contaminate surface water or ground water should be included.

The effects on the environment of chemicals in cooling tower blowdown and drift should also be considered in this section. Using the contaminant concentrations allowed by effluent guidelines (40 CFR Part 423), estimate the resulting stream concentrations and the relationship of these concentrations to water quality standards at various distances and water flow variations (including the average 7-day once-in-ten-years low flow, the lowest control flow, and the lowest recorded minimum for the receiving water body). Include a description of the method of calculation.

Any anticipated chemical or biocide contamination of domestic water supplies (from surface water bodies or ground water) should be identified and discussed. Rate of percolation of each contaminant into the water supply, travel time from the station to points of public water supply, dilution factors, dispersion coefficients, and the resulting concentrations in the water should be estimated.

Resulting concentrations should be compared with applicable effluent limitations (40 CFR Part 423) and related water quality standards. Systems considered here should include roof and yard drains and all other miscellaneous low-volume discharge systems.

5.4 Effects of Sanitary Waste Discharges

Sanitary waste systems are described in Section 3.7. The expected discharges should be discussed as in Section 5.3 and compared with appropriate effluent guidelines and water quality standards for municipal systems under 40 CFR Part 133, "Secondary Treatment Information."

5.5 Effects of Operation and Maintenance of the Transmission Systems

The environmental effects of operation and maintenance of the transmission system required to tie in the proposed facility to the preexisting network should be evaluated. The evaluation of effects should make clear the applicant's plans for maintenance of the right-of-way and required access roads. Plans for use of herbicides and pesticides should indicate types, volume, concentrations, and manner and frequency of use. Include references to authoritative guidelines assuring that the applicant's procedures are acceptable. Resulting effects on plant life, wildlife habitat, land resources, and scenic values should be evaluated.

New access roads may increase the exposure of transmission line corridors to the public. The applicant should consider the effect of this increased exposure on resident wildlife.

This section of the report should also discuss the potential environmental impacts of any electrical effects

[19] Models and assumptions for calculating doses are described in a guide entitled "Calculation of Annual Average Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Implementing Appendix I," which is currently under development.

identified in Section 3.9 and any operating and maintenance practices which will be adopted to minimize these.

5.6 Other Effects

The applicant should discuss any effects of plant operation that do not clearly fall under any single topic of Sections 5.1 to 5.5. These may include changes in land and water use at the plant site, interaction of the plant with other existing or projected neighboring plants, effect of ground water withdrawal on ground water resources in the vicinity of the plant, and disposal of solid and liquid wastes other than those discussed in Sections 5.3 and 5.4. Any features of the plant producing noise levels outside the suggested levels[20] should be specifically identified and discussed in relation to adjacent occupancy, both day and night, based on measurements of preconstruction ambients.

5.7 Resources Committed

Any irreversible and irretrievable commitments of resources due to plant operation should be discussed. This discussion should include both direct commitments, such as depletion of uranium resources, and irreversible environmental losses, such as destruction of wildlife habitat and consumptive use or diversion of water.

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

In evaluating long-term effects for their net consequences, the applicant may consider, as an example, the impact of thermal and chemical discharges on fish. There may be severe losses in the local discharge area. The local population change may or may not be a net loss. Therefore, changes in population of important species caused by or expected to be caused by the operation of the plant should be examined with the view of determining whether they represent long-term net losses or long-term net gains. The considerations are also applicable to Chapters 9 and 10 of the report.

5.8 Decommissioning and Dismantling

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

[20] See "The Industrial Noise Manual," American Industrial Hygiene Association, Detroit, Mich,; "Noise Abatement and Control: Departmental Policy Implementation Responsibility and Standards," HUD Circular 1390.2 (1971); and "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," EPA, 550/9-74-004, U.S. Superintendent of Documents, Washington, D.C.

CHAPTER 6

EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

The intent of this chapter is to describe in detail the means by which the applicant collected the baseline data presented in other chapters and to describe the applicant's plans and programs for monitoring the environmental impacts of site preparation, plant construction, and plant operation.

Section 6.1 (below) is addressed to the proposed program for assessing the characteristics of the site and the surrounding region (including transmission corridors) before plant operation. The purpose of this program is to establish a reference framework for assessing subsequent environmental effects attributable to site preparation, plant construction, and plant operation.

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

If the applicant chooses to make an early separate filing of environmental data and as permitted by §2.101(a) 39 FR 14508 a tentative evaluation prior to receiving and evaluating a full year's data, particular attention should be paid to the description of sampling design, sampling frequency, and statistical methodology and validity (including calibration checks and standards) in order to justify the scope of the program, the timing and scheduling of the data collection, and other technical validation that will assure the review staff that sufficient information will ultimately be available for the publication of the FES. In cases in which the early separate filing of environmental data is to be made and an authorization requested under 10 CFR Part 50, §50.10(e), it is to the applicant's benefit to file a preliminary monitoring program design in advance of filing the full environmental report in order to expedite staff review for the Draft Environmental Statement (DES).

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

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

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

6.1 Applicant's Preoperational Environmental Programs

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

Where an effect of site preparation or facility construction may alter a previously measured or observed environmental condition, the program for determining the modified condition should be described. Refer to the discussion in Section 4.5, as appropriate.

Where information from the literature has been used by the applicant, it should be concisely summarized and documented by reference to original data sources. Where the availability of original sources that support important conclusions is limited, the applicant should provide either extensive quotations or references to accessible secondary sources.[21] In all cases, information derived from published results should be clearly distinguished from information derived from the applicant's field measurements.

6.1.1 Surface Waters

When a body of surface water may be affected by the proposed facility or a practicable alternative, the

[21] Any reports of work (e.g., ecological surveys) supported by the applicant that are of significant value in assessing the environmental impact of the facility may be included as appendices or supplements to the environmental report if these reports are not otherwise generally available.

applicant should describe the programs by which the background condition of the water and the related ecology were determined and reported in Section 2.4. The applicant should have sufficient data to permit staff verification of any predictive computations or models used in the evaluation of environmental effects.

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

In addition to describing the programs for obtaining the data, the applicant should describe any computational models used in predicting effects. The applicant should indicate how the models were verified and calibrated, and what error limits apply to the prediction adjusted seasonally or diurnally as appropriate.

6.1.1.2 Ecological Parameters. The applicant should describe the preoperational program used to determine the ecological characteristics presented in Section 2.2. Those portions of the program concerned with determining the presence and abundance of important aquatic and amphibious species (identified in Section 2.2) should be detailed in terms of frequency, pattern, and duration of observation. The applicant should describe how taxonomic determinations were made and validated. In this connection, the applicant should discuss its reference collection of voucher specimens or other means whereby consistent identification will be assured.

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

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

Parameters of stress for important species (as defined in Section 2.2) that could be affected by plant discharges should be identified. The methodology for determining such parameters should be reviewed with respect to applicability to actual local conditions anticipated during operation, including interactive effects among multiple effluents and existing constituents of the surface water body concerned.

6.1.2 Ground Water

In those cases in which the proposed facility or a practicable design alternative may potentially affect local ground water, the program leading to assessment of potential effects should be described.

6.1.2.1 Physical and Chemical Parameters. The properties and configuration of the local aquifer should have been defined in sufficient detail (in Section 2.4) to permit a reasonable projection of the effects of plant operation on the ground water. Where inferred transmissibilities or permeabilities are estimated because of incomplete field data, the basis for the estimate and the error limits of the estimate should be included in the discussion of the field data program and experiment design. Methods for obtaining information on ground water levels and ground water quality should be described.

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

6.1.3 Air

The applicant should describe the program for obtaining information on local air quality, if relevant, and local and regional meteorology. The description should show the basis for predicting such effects as the dispersion of gaseous effluents and alteration of local climate (e.g., fogging, icing, precipitation augmentation, or other phenomena) and should present the methodology for gathering baseline data.

6.1.3.1 Meteorology. The applicant should identify sources of meteorological data reported in Section 2.3. Locations and elevations of observation stations, instrumentation, and frequency and duration of measurements should be specified, both for the applicant's measuring activities and for activities of governmental agencies or other organizations on whose information the applicant intends to rely. For applicant's preoperational and operational program, include descriptions of instruments, performance specifications, calibration and maintenance procedures, data output and recording systems and locations, and data analysis procedures.

6.1.3.2 Models. Any models used by the applicant, either to derive estimates of basic meteorological information or to estimate the effects of effluent systems, should be described and their validity and accuracy discussed.

6.1.4 Land

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

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

6.1.4.2 Land Use and Demographic Surveys. The applicant should describe his problem for identifying the actual land use in the site environs and for acquiring demographic data for the region as reported in Section 2.1.

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

6.1.4.3 Ecological Parameters. In this section, the applicant should discuss the program used to assess the ecological characteristics of the site, with primary reference to important terrestrial biota identified in Section 2.2. In general, the considerations involved are similar to those suggested in connection with aquatic biota (Paragraph 6.1.1.2). However, the differences in habitat, differences in animal physiology, and other pertinent factors will, of necessity, influence the design of the assessment program. The applicant should present, as in Paragraph 6.1.1.2, an analysis of the program in terms of taxonomic validation, rationale for its predictive aspects, and the details of its methodology.

6.1.5 Radiological Monitoring

The preoperational program should be described in detail in the Environment Report–Construction Permit Stage. Specific information should be provided on (a) the types of samples to be collected, (b) sampling locations, (c) analyses to be performed on each sample, (d) general types of sample collection equipment, (e) sample collection and analysis frequency, (f) the analytical sensitivity[22] for each analysis, and (g) the approximate starting date and duration of the program. The discussion should include the justification for the choice of sampling sites, analyses, and sampling frequencies. Review of this description will be facilitated if the applicant includes maps of sampling locations, as well as tabular summary of the program. The applicant should also describe how he expects to extend the preoperational program into the operational phase and in what manner the results of the preoperational program may be used to affect the design of the operational program. Guidance for both the preoperational program and operational program is provided in Regulatory Guide 4.1, "Measuring and Reporting of Radioactivity in the Environs of Nuclear Power Plants." Additional guidance will be provided in a regulatory guide currently being developed, "Guide for the Preparation of Environmental Technical Specifications for Nuclear Power Plants." In addition, EPA report ORP/SID 72-2, "Environmental Radioactivity Surveillance Guide," recommends methods for conducting a minimum level of environmental radiation surveillance outside the plant site boundary of light-water-cooled nuclear power facilities.

The applicant should summarize any information available from the literature regarding background radiological characteristics of the site which were considered in designing the program (reference may be made to Section 6.3 as appropriate).[23]

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

6.2 Applicant's Proposed Operational Monitoring Programs

Operational monitoring programs may not be fully developed at the time of applying for a construction permit. The applicant should, to the extent feasible, describe the general scope and objectives of his intended programs and provide a tentative listing of parameters which he believes should be monitored for detailed evaluation. This listing should include numerical excerpts from the water, air, or radiological standards against which the proposed monitoring program will be measured as understood at the time of initial submission of the environmental report.

The "Guide for the Preparation of Environmental Technical Specifications for Nuclear Power Plants" will describe information to be submitted with an application for an operating license.

In the "Environmental Report–Construction Permit Stage," the operational program need only be discussed to the extent that it is expected to differ (if at all) from the ongoing preoperational program. If in the "Environmental Report–Operating License Stage," there are no

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[22] The lower limit of detection (LLD) as defined in HASL-300 (Rev. 8/73).

[23] A report on this subject by Scientific Committee 43 of the National Council on Radiation Protection and Measurements is in preparation. When copies become available, they may be obtained from Publications, NCRP, P.O. Box 30175, Washington, D.C. 20014.

differences between the preoperational programs (as finally formulated) and operational programs, the applicant need only make a statement to that effect and provide a commitment to conduct the operational program. If there are differences in the operational program, the applicant should describe the reasons for the differences. The applicant should also discuss any plans and rationale for updating the program during plant operation.

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

6.3 Related Environmental Measurement and Monitoring Programs

When the applicant's site lies within a region for which environmental measurement or monitoring programs are carried out by public or other agencies not directly supported by the applicant, any such related programs known to the applicant should be identified and discussed. Relevance of such independent findings to the proposed facility's effects should be described, and plans for exchange of information, if any, should be presented. Agencies responsible for the programs should be identified and, to the extent possible, the procedures and methodologies employed should be briefly described.

6.4 Preoperational Environmental Radiological Monitoring Data

Data from the preoperational program may not be available at the time of submission of the "Environmental Report–Construction Permit Stage." Accordingly, the applicant should submit for Section 6.4, as a later supplement to the "Environmental Report–Operating License Stage," 6 to 12 months[24] of preoperational environmental radiological monitoring data.

[24]The minimum amount of preoperational data may be submitted if it includes data from a crop harvest and a complete grazing season. All media with a collection frequency less than semiannual (e.g., annual or once in three years) should be included in the 6 to 12 months of data submitted.

CHAPTER 7

ENVIRONMENTAL EFFECTS OF ACCIDENTS

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

7.1 Station Accidents Involving Radioactivity

The detailed requirements for analysis of accidents are contained in the proposed Annex to Appendix D of 10 CFR Part 50. This Annex is reproduced as Appendix 5 of this guide.

Applicants may, for purposes of environmental reports, take the option in the calculation of χ/Q values of using either of two meteorology assumptions for all accident cases:

1. χ/Q values may be determined from onsite meteorological data at the 50% probability level or

2. χ/Q values may be determined at 10% of the levels in Regulatory Guide 1.3 or 1.4.

7.2 Other Accidents[25]

In addition to accidents that can release radioactivity to the environs, accidents may occur that, although they do not involve radioactive materials, have consequences that may affect the environment. Such accidents as chemical explosions, fires, and leakage or ruptures of vessels containing oil or toxic materials can have significant environmental impacts. These possible accidents and associated effects should be identified and evaluated (see Regulatory Guide 1.70.8, "Additional Information–Nearby Industrial, Transportation, and Military Facilities".)

[25] The Commission's Environmental Statement will discuss the environmental impact of accidents that may occur during transport of fresh and spent fuel, irradiated fuel, and radioactive wastes. See WASH-1238, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," USAEC, Directorate of Regulatory Standards, December 1972, and 38 FR 3334, February 5, 1973.

CHAPTER 8

ECONOMIC AND SOCIAL EFFECTS OF PLANT CONSTRUCTION AND OPERATION

The purpose of this chapter is to present the applicant's assessment of the economic and social effects of the proposed facility.

There are, of course, limitations on the extent to which the applicant can evaluate all the social and economic benefits and costs of the construction and operation of a nuclear facility that may have a productive life of 30 years or more. The wide variety of benefits and costs are not only difficult to assess, but many are not amenable to quantification nor even to estimation in commensurable units. Some primary benefits such as the generated electrical energy are, to a degree, measurable, as are the capital costs and operating and maintenance costs of the proposed facility. On the other hand, numerous environmental costs and their economic and social consequences are not readily quantified.[26]

Second- and higher-order costs or benefits (i.e., impacts flowing from first-order social and economic impacts) need be discussed by the applicant only where they would significantly modify the aggregate of costs or benefits, thus affecting the overall cost-benefit balance.

8.1 Benefits

The primary benefits of the proposed nuclear facility are those inherent in the value of the generated electricity delivered to consumers. The applicant should report, as shown in Table 2, the expected average annual kilowatt-hours of electrical energy to be generated. Further, a breakdown of the expected use of electricity in the applicant's service area should be provided for the major classes identified in the Federal Power Commission publication, "National Power Survey."[27] These benefits may be optionally expressed in dollars by showing expected average annual revenues. If furnished, the basis of assigning dollar values should be clearly stated. The year-by-year forecasts of such revenues for the life of the plant should be discounted to present worth, using a nominal discount rate reflecting the average cost of capital.

The importance of the proposed facility in providing adequate reserves of generating capacity to ensure a reliable supply for the applicant's service area (and associated power pool, if any) is discussed in Section 1.1. The increase in the probabilities of the extent and duration of electrical shortages if the proposed plant (or its equivalent capacity) is not built by the proposed date should be estimated, and the applicant should appraise the likely social and economic impacts of such shortages. The benefits in averting these impacts should be related to regional experience, if any, with brownouts and emergency load-shedding and the applicant's plans or procedures for meeting such emergencies.

Other primary benefits of some nuclear electrical generating facilities may be in the form of sales of steam or other products or services. Revenues from such sales should be estimated. The use of waste or reject heat for desalination or for other processes could expand the benefits of nuclear plants. Such benefits, if claimed, should be accompanied by an estimate of the degree of certainty of their realization.

There are other social and economic benefits which affect various political jurisdictions or interests to a greater or lesser degree. Some of these reflect transfer payments or other values which may partially, if not fully, compensate for certain services, as well as external or environmental costs, and this fact should be reflected in the designation of the benefit. A list of examples follows:

- Tax revenues to be received by local and State governments.
- Temporary and permanent new jobs created and payroll.
- Incremental increase in regional product (value-added concept).
- Enhancement of recreational values through making available for public use any parks, artificially created cooling lakes, marinas, etc.
- Enhancement of aesthetic values through any special design measures as applied to structures, artificial lakes or canals, parks, etc.
- Environmental enhancement in support of the propagation or protection of wildlife and the improvement of wildlife habitats.
- Creation and improvement of local roads, waterways, or other transportation facilities.
- Increased knowledge of the environment as a consequence of ecological research and environmental monitoring activities associated with plant operation, and technological improvements from the applicant's research program.
- Creation of a source of heated discharge which may be used for beneficial purposes (e.g., in aquaculture, in improving commercial and sport fishing, or in industrial, residential, or commercial heating).
- Provision of public education facilities (e.g., a visitors' center).

The applicant should discuss significant benefits that may be realized from the construction and operation of the proposed plant. Where the benefits can be

[26] The estimate of generated electrical energy should reflect the outages consistent with the applicant's forced outage ratio experience and should include outages induced by natural phenomena such as floods, droughts, tornadoes, or hurricanes (see Sections 2.3 and 2.4).

[27] Copies may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

expressed in monetary terms, they should be discounted to present worth. In each instance where a particular benefit is discussed, the applicant should indicate, to the extent practical, who is likely to be affected and for how long. In the case of aesthetic impacts that are difficult to quantify, the applicant should provide pictorial drawings of significant station structures or environmental modifications visible to the public and also of parks or other recreational facilities on the site which will be available for public use. The details should be drawn from information presented in Sections 2.6 and 3.1.

8.2 Costs

The economic and social costs resulting from the proposed nuclear facility and its operation are likewise complex and should be appraised.

The primary *internal* costs are: (a) the capital costs of land acquisition and improvement; (b) the capital costs of facility construction; (c) the incremental capital costs of transmission and distribution facilities; (d) fuel costs, including the cost of spent fuel disposition; (e) other operating and maintenance costs, including license fees and taxes; (f) plant decommissioning costs; and (g) research and development costs associated with potential future improvements of the facility and its operation and maintenance. As in the case of benefits, the applicant should discount these costs to present worth.

The applicant should provide the types of information listed below for nuclear and alternative power generation methods. If the applicant includes a coal-fired plant as a viable alternative to a nuclear power plant, information should be provided for both a coal-fired plant with sulfur removal equipment and one that burns low-sulfur coal.

Items (1) through (5) are necessary to run the CONCEPT code used by Regulatory staff. Inclusion of this information in the applicant's environmental report could expedite the staff's review process. Item (6) would

<u>Information Requested</u>

(1) Interest during construction ______ %/year, ______ compound rate

(2) Length of construction workweek ______ hours/week

(3) Estimated site labor requirement ______ man-hours/kWe

(4) Average site labor pay rate (including fringe benefits) effective at month and year of NSSS order ______ $/hour

(5) Escalation rates
- Site labor ______ %/year
- Materials ______ %/year
- Composite escalation rate ______ %/year

(6) Power Plant Cost[a]

<u>Direct Costs</u>	<u>Unit 1</u>	<u>Unit 2</u>
a. Land and land rights	______	______
b. Structures and site facilities	______	______
c. Reactor (boiler) plant equipment	______	______
d. Turbine plant equipment not including heat rejection systems	______	______
e. Heat rejection system	______	______
f. Electric plant equipment	______	______
g. Miscellaneous plant equipment	______	______
h. Spare parts allowance	______	______
i. Contingency allowance	______	______
Subtotal	______	______

<u>Indirect Costs</u>		
a. Construction facilities, equipment and services	______	______
b. Engineering and construction management services	______	______
c. Other costs		
d. Interest during construction (@______%/year)	______	______
Escalation during construction (@______%/year)	______	______
Total Plant Cost, @ Start of Commercial Operation	______	______

[a]Cost components of nuclear plants to be included in each cost category listed under direct and indirect costs in Part (6) above are described in "Guide for Economic Evaluation of Nuclear Reactor Plant Designs," U.S. Atomic Energy Commission, NUS-531, Appendix B.

permit the staff to compare detailed cost categories to distinguish any significant differences which might exist between the applicant's estimate and the CONCEPT model.

In order to supplement the economic information provided in Chapter 9 of the environmental report, the following cost information should be provided for (1) coal-fired units (one use which would utilize low-sulfur coal and a second which would use high-sulfur coal with stack gas cleaning), (2) oil-fired units, and (3) nuclear power units.

The environmental report should include the estimated cost of generating electric energy in mills per kilowatt-hour for the proposed nuclear plant and for alternative fossil-fired plants in the detail given below. It should be stated whether the costs of fuel and of operation and maintenance are initial costs or levelized costs over some period of operation and, in the latter case, what assumptions are made about escalation.

There are also external costs. Their effects on the interests of people should be examined. The applicant should supply, as applicable, an evaluation plus supporting data and rationale regarding such external social and economic costs as noted below.[28] For each cost, the applicant should describe the probable number and location of the population group adversely affected, the estimated economic and social impact, and any special measures to be taken to alleviate the impact.

Temporary external costs[29] include: shortages of housing; inflationary rentals or prices; congestion of local streets and highways; noise and temporary aesthetic disturbances; overloading of water supply and sewage treatment facilities; crowding of local schools, hospitals, or other public facilities; overtaxing of community services; the disruption of people's lives or the local community caused by acquisition of land for the proposed site.

Long-term external costs[30] include impairment of recreational values (e.g., reduced availability of desired species of wildlife and sport fish, restrictions of access to land or water areas preferred for recreational use); deterioration of aesthetic and scenic values; restrictions on access to areas of scenic, historic, or cultural interest; degradation of areas having historic, cultural, natural, or archeological value; removal of land from present or contemplated alternative uses; creation of locally adverse meteorological conditions (e.g., fog and plumes from cooling towers, cooling ponds, etc.); creation of noise, especially by mechanical-draft cooling towers; reduction of regional product due to displacement of persons from the land proposed for the site; lost income from recreation or tourism that may be impaired by environmental disturbances; lost income of commercial fishermen attributable to environmental degradation; decrease in real estate values in areas adjacent to the proposed facility; increased costs to local governments for the services required by the permanently employed workers and their families. In discussing the costs, the applicant should indicate, to the extent practical, who is likely to be affected and for how long.

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[28] For convenience of treatment, the listed cost examples have been divided into long-term (or continuing) costs and the temporary costs generally associated with the period of construction or the readjustment of the lives of persons whose jobs or homes will have been displaced by the purchase of land at the proposed site.

[29] Refer, as appropriate, to the information presented in Chapter 4.

[30] Refer, as appropriate, to the information presented in Chapter 5.

	Mills/Kilowatt-Hour
Fixed Charges[a]	
Cost of money	
Depreciation	
Interim replacements	
Taxes	
Fuel-Cycle Costs[b]	
For fossil-fired plants, costs of high-sulfur coal, low-sulfur coal, oil, or gas	
For nuclear plants:	
Cost of U_3O_8 (yellowcake)	
Cost of conversion and enrichment	
Cost of conversion and fabrication of fuel elements	
Cost of processing spent fuel	

	Mills/Kilowatt-Hour
Carrying charge on fuel inventory	
Cost of waste disposal	
Credit for plutonium or U-233	
Costs of Operation and Maintenance[c]	
Fixed component	
Variable component	
Costs of Insurance	
Property insurance	
Liability insurance	

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[a] Give the capacity factor assumed in computing these charges, and give the total fixed-charge rate as a percentage of plant investment.

[b] Include shipping charges as appropriate. Give the heat rate in Btu/kilowatt-hour.

[c] Give separately the fixed component that in dollars per year does not depend on capacity factor and the variable component that in dollars per year is proportional to capacity factor.

CHAPTER 9
ALTERNATIVE ENERGY SOURCES AND SITES

The intent of this chapter is to present the basis for the applicant's proposed choice of site and nuclear fuel among the available alternative sites and energy sources. Accordingly, the applicant should discuss the range of practicable alternatives and should demonstrate that none of these is clearly to be preferred to the proposed site-plant combination. It is recognized that planning methods differ among applicants. However, the applicant should present its site-plant selection process as the consequence of an analysis of alternatives whose environmental costs and benefits were evaluated and compared and then weighed against those of the proposed facility.

This chapter should encompass information relevant both to the availability of alternatives and to their relative merits. Two classes of alternatives should be considered: those that can meet the power demand without requiring the creation of new generating capacity and those that do require the creation of new generating capacity.

9.1 Alternatives Not Requiring the Creation of New Generating Capacity

Practicable means that meet the projected power demand with adequate system reliability and which do not require the creation of additional generating capacity should be identified and evaluated.[31] Such alternatives may include purchased energy, reactivating or upgrading an older plant, or base load operation of an existing peaking facility. Such alternatives should be analyzed in terms of cost, environmental impact, adequacy, reliability, and other pertinent factors. If such alternatives are totally unavailable or if their availability is highly uncertain, the relevant facts should be stated. This analysis is of major importance because it supports the justification for new generating capacity.

9.2 Alternatives Requiring the Creation of New Generating Capacity

In this guide, an alternative constituting new generating capacity is termed a "site-plant combination" in order to emphasize that the alternatives to be evaluated should include both site and energy source options. A site-plant combination is a combination of a specific site (which may include the proposed site) and a particular category of energy source (nuclear, fossil-fueled, hydroelectric, geothermal) together with the transmission hookup. A given site considered in combination with two different energy sources is regarded as providing two alternatives.

[31] If transmission facilities must be constructed in order to secure the energy from alternative sources, this should be discussed.

9.2.1 Selection of Candidate Areas[32]

In this section the applicant should present an initial survey of site availability using a screening process which, after identifying areas containing possible sites, eliminates those whose less desirable characteristics are recognizable without extensive analysis. The purpose of this screening is to identify a reasonable number of realistic siting options. In assessing potential candidate areas, the applicant may place primary reliance on published materials.

The geographical regions considered by the applicant may be within or outside the applicant's franchise service area. It is expected that each area considered will be small enough for any site developed within it to have essentially similar environmental relationships (i.e., thermal discharge to the same body of water, proximity to the same urban area). The areas considered should not be restricted to those containing land actually owned by the applicant.

If a State, region, or locality has a power plant siting law, the law should be cited and any applicable constraints described.

The applicant should display the areas being appraised by means of maps and charts portraying the power network,[33] environmental and other features, and other relevant information. (A consistent identification system should be established and retained on all graphic and verbal materials in this section.) The map or maps should be clearly related to the applicant's service area (and adjacent areas if relevant). They should display pertinent information such as the following:

1. Areas considered by the applicant;
2. Major centers of population density (urban, high density, medium density, low density, or similar scale);
3. Water bodies suitable for use in cooling systems;
4. Railroads, highways (existing and planned), and waterways suitable for fuel and waste transportation;
5. Important topographic features (such as mountains, marshes, fault lines);
6. Dedicated land-use areas (parks, historical sites, wilderness areas, testing grounds, airports, etc.);
7. Primary generating plants, together with effective operating capacity in megawatts, both electrical and thermal, and indication of fuel (all plants of the same type at the same location should be considered a single source);
8. Other generating additions to the network to be installed before the proposed facility goes on line;

[32] As used in Chapter 9, the term "area" is defined as several square miles (large enough to contain several sites).

[33] To avoid repetition, the applicant should refer, as appropriate, to material presented in Section 1.1.

9. Transmission lines of 115 kV or more, and termination points on the system for proposed and potential lines from the applicant's proposed facility; and

10. Major interconnections with other power suppliers.

Maps of areas outside the applicant's service area should include the probable transmission corridor to the applicant's system.

Suitable correlations should be made among the maps. For example, one or more of the maps showing environmental features may be to the same scale as a map showing power network configurations; or present generating sites and major transmission lines may be overlaid on the environmental maps, if this is helpful to the discussion.

The applicant should briefly discuss the availability of fuel or other energy sources at the areas considered. It is recognized that conditions with regard to alternatives to nuclear fuel vary for different applicants. Oil and coal may be readily available in many areas, although limitations on maximum sulfur content or transportation costs may restrict or prevent their use. (Where supplies are adequate and its use is otherwise appropriate, natural gas may be an alternative in some areas.) Hydroelectric and geothermal sources should also be considered if available. In some situations, combinations of energy sources (e.g., coal-fired base-load plant plus gas-turbine peaking units) may be practical alternatives. The discussion should clearly establish the energy-source alternatives.

Using the materials described above, the applicant should provide a condensed description of the major considerations which led to the final selection of the candidate areas.

The following remarks may apply in specific instances:

1. The first general geographic screening may be based on power load and transmission considerations.

2. Certain promising areas may be identified as suitable for only one type of fuel; others may be broadly defined at this stage of analysis (e.g., a stretch of coastline) and may admit several fuel-type options.

3. Only the determining characteristics of the identified areas need be discussed. Specific tracts need not be identified unless already owned by the applicant.

4. If areas outside the service area are not considered during this phase of the decision process, the reasons for not considering them should be provided.

5. If certain fuel types are eliminated in selecting candidate areas because of predicted unavailability or because of economic factors, supporting information should be supplied.

6. In eliminating a fuel type at a site on the grounds of monetary cost, the applicant should make clear that the excess cost over a preferred alternative outweighs any potential advantages of the eliminated fuel type with respect to environmental protection.

7. The compatability with any existing land-use planning programs of the development of each candidate area should be indicated and the views, if any, of local planning groups and interested citizens concerning use of the candidate area should be summarized.

8. If it is proposed to add a nuclear unit to a station where there are already thermal electric generating units under construction or in operation, the local and regional significance of concentrating a large block of thermal generating capacity at one location should be given specific consideration.

9.2.2 Selection of Candidate Site-Plant Alternatives[34]

At this point, the number of suitable areas will have been reduced, making possible investigation of a realistic set of alternative site-plant combinations. These alternative combinations should be briefly described. The description should include site plans indicating locations considered for the plant, access facilities, and any transmission considerations that significantly affect site desirability.

The criteria to be used in selecting the candidate site-plant alternatives are essentially the criteria used in selecting candidate areas. Application of these criteria in greater depth may be required, however, since the relative merits of the various site-plant combinations may be less obvious than those of the initially identified areas. Furthermore, although a particular area may be judged unsuitable because of one major overriding disadvantage, establishment of the suitability of a given site-plant combination may require balancing both favorable and unfavorable factors (benefits versus environmental and other costs).

The applicant is not expected to conduct detailed environmental studies at alternative sites; only preliminary reconnaissance-type investigations need be conducted. Neither is it expected that detailed engineering design studies will be made for all alternative plants or that detailed transmission route studies will be made for all alternatives.

9.3 Cost-Benefit Comparison of Candidate Site-Plant Alternatives

A cost-effectiveness analysis of realistic alternatives in terms of both economic and environmental costs should be made, to show why the proposed site-plant combination is preferred over all other candidate alternatives for meeting the power requirement. In presenting the cost-effectiveness analysis, the applicant should use, insofar as possible, a tabular format showing side-by-side comparison or alternatives with respect to selection criteria.

Quantification, while desirable, may not be possible for all factors because of lack of adequate data. Under such circumstances, qualitative and general comparative statements supported by documentation may be used.

[34] The range of candidate site-plant alternatives selected by the applicant should include other energy source options (coal, oil, gas, hydro, geothermal) as practicable.

Where possible, experience derived from operation of plants at the same or at an environmentally similar site may be helpful in appraising the nature of expected environmental impacts.

Various criteria have been suggested in this guideline for use in comparing the alternatives and the proposed facility. The criteria chosen by the applicant should reflect benefits and costs[35] which were evaluated in selecting the site-plant candidates. The following itemization of evaluatory factors may be helpful as a checklist:

Engineering and Environmental Factors:
- Meteorology
- Geology
- Seismology
- Hydrology
- Population density in site environs
- Access to road, rail, and water transportation
- Fuel supply and waste disposal routes
- Cooling water supply
- Sensitivity of aquatic and terrestrial habitats affected
- Commitment of resources
- Dedicated areas
- Projected recreational usage
- Scenic values

[35]The applicant may use, if the necessary data are available, the method for calculating generating costs discussed in Chapter 10. The analysis should highlight significant environmental differences among alternative sites which can be balanced against dollar cost differentials.

Transmission Hookup Factors:
- Access to transmission system in place
- Problems of routing new transmission lines
- Problems of transmission reliability
- Minimization of transmission losses

Construction Factors:
- Access for equipment and materials
- Access, housing, etc., for construction workers

Land Use Factors, including compatibility with zoning or use changes.

Institutional Factors (e.g., State or regional site certification).

Cost Factors:
- Construction costs including transmission
- Annual fuel costs
- Annual maintenance costs

Operating Factors:
- Load-following capability
- Transient response

Alternative Site Cost Factors:
- Land and water rights
- Base station facilities
- Main condenser cooling system
- Main condenser cooling intake structures and discharge system
- Transmission and substation facilities
- Access roads and railroads
- Site preparation including technical investigations

CHAPTER 10
PLANT DESIGN ALTERNATIVES

The applicant should, in this chapter, show how the proposed plant design was arrived at through consideration of alternative designs of identifiable systems and through their comparative assessment.

The significant environmental interfaces of a nuclear power plant will be associated with the operation of certain identifiable systems. The applicant's proposed plant should incorporate a combination of these identifiable systems, each of which has been selected through a cost-effectiveness analysis (see discussion in Section A, "Introduction") of economic and other factors as the preferred choice within its category. In some instances, the interaction of these systems may be such as to require their selection on the basis of a preferred combination rather than on the basis of individual preferred systems. For example, an alternative cooling system may have to be evaluated in combination with a preferred chemical effluent system that would be used with it.

The applicant's discussion should be organized on the basis of plant systems and arranged according to the following list:

- Circulating water system (exclusive of intake and discharge)
- Intake system for circulating water
- Discharge system for circulating water
- Other cooling systems (including intake and discharge where not treated in the preceding three items)
- Biocide systems (all cooling circuits)[36]
- Chemical waste treatment[36]
- Sanitary waste system[36]
- Liquid radwaste systems (see Section 10.7)
- Gaseous radwaste systems (see Section 10.8)
- Transmission facilities
- Other systems

The following should be considered in preparing the discussion:

a. **Range of alternatives.** The applicant's discussion should emphasize those alternative plant 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 costs are appreciably different. The applicant should include alternatives that meet the following criteria: (1) they provide improved levels of environmental protection (in the case of systems subject to 40 CFR Part 423, the analysis should focus on alternative systems which comply with 40 CFR Part 423 but which are a better environmental solution taking into account impacts on air quality, aesthetics, etc.), and (2) although not necessarily economically attractive, they are based on feasible technology available to the applicant during the design stage.

In cases where the proposed system in the application does not comply with thermal effluent limitations under Sections 301 and 306 of Pub. Law 92-500 and no disposition of any request for waiver under Section 316a is expected until after issuance of a construction permit, the environmental report should clearly identify and provide supporting analysis for the most feasible alternative cooling system that would be selected in the event the request for modification is denied.

b. **Normalization of cost comparison.** Alternatives should be compared on the basis of an assumed fixed amount of energy generated for distribution outside the plant. (Thus, any effect of an alternative on plant power consumption should be discussed.)

c. **Effect of capacity factor.** The projected effect of alternatives on plant capacity factor should be given and explained for capacity factors of 60, 70, and 80 percent.

d. **Monetized costs.** The acquisition and operating costs of individual systems and their alternatives (as well as costs of the total plant and transmission facility and alternatives) should be expressed as power generating costs. The latter will be derived from cost elements compounded or discounted (as appropriate) to their present values as of the date of initial commercial operation and will be converted to their annualized values. The method of computation is shown in Table 3. The individual cost items in this table should be used as applicable. The total cost will be the sum of:

- Capital to be expended up until the scheduled date of operation.[37]
- Interest to the date of operation on all expenditures prior to that date.
- Expenditures subsequent to the scheduled date of operation discounted to that date. In calculations, the applicant should assume a 30-year plant life.[38]

In computing the annualized present value of plant systems and their alternatives, the following cost elements are suggested:

- Engineering design and planning costs
- Construction costs
- Interest on capital expended prior to operation
- Operating, maintenance, and fuel (if applicable) costs over the 30-year life of the plant

[36] Systems that meet effluent limitation guidelines of 40 CFR Part 423.

[37] For operating license proceedings, costs should be based on capital to be expended to complete the facility.

[38] Use 30-year life for steam-electric generating plants. For other types of electric generating plants, use generally accepted values.

- Cost of modification or alteration of any other plant system if required for accommodation of alternatives to maintain plant capacity (see item b above)
- Maintenance costs for the transmission facility (if applicable)
- Cost of supplying makeup power during a delay resulting from an alternative design choice which will not meet the power requirement by the scheduled inservice date

e. **Environmental costs.** Environmental effects of alternatives should be fully documented. 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 comparison to the effects of the subsystem chosen for the proposed design. In either case, the derivation of the evaluations should be completely documented.

Table 4 presents a set of environmental factors which should be considered in comparing alternative plant systems in the cost-effectiveness analysis. Although incomplete, the factors listed are believed to represent the principal environmental effects of power plant construction and operation that can be evaluated by generally accepted techniques. The table provides for three key elements of environmental cost evaluation:

1. A description of each effect to be measured (column 3).
2. Suggested units to be used for measurement (column 4). The AEC recognizes the difficulty, if not the impossibility, of using the assigned units for every item in Table 4 in each case, given the current state of the art. The applicant may elect to use other units, provided they are meaningful to the informed public and adequately reflect the impact of the listed environmental effects.
3. A suggested methodology of computation (column 5). Computation of effects in response to each block in Table 4, e.g., 1.1, 1.2, etc., should be given without adjustment for effects computed in other blocks for the same population or resource affected. However, provision is made in Table 4 (i.e., 1.9 and 4.9) to account for combined effects that may be either less than or greater than the sum of individual effects.

In discussing environmental effects, the applicant should specify not only the magnitude of the effect (e.g., pounds of fish killed or acres of a particular habitat destroyed) but also the relative effect, that is, the fraction of the population or resource that is affected. See discussion in Section 5.7.

In some specific cases, accurate estimation of an effect which the applicant believes to be very small may require a data collection effort that would not be commensurate with the value of the information to be obtained. In such cases, the applicant may substitute a preferred measure which conservatively estimates environmental costs for the effect in question, provided the substituted measure is clearly documented and realistically evaluates the potentially detrimental (i.e., worst case) aspects of the effect, and provided the measure is applied consistently to all alternatives.

f. **Supporting details.** In the following subsections, the applicant should discuss design alternatives for each of the relevant plant systems (i.e., cooling system, intake system, etc.). The discussion should describe each alternative, should present estimates of its environmental impact, and should compare the estimated impact with that of the proposed system. The assumptions and calculations on which the estimates are based should be presented. Engineering design and supporting studies, e.g., thermal modeling, performed to assess the impact of alternative plant systems should be limited in scope to those efforts required to support the cost-effectiveness analysis that led to selection of the proposed design.

g. **Presentation of alternative designs.** The results should be tabulated for each plant system in a format consistent with the utilization of the definitions in Table 4.

The monetized costs of the proposed systems and alternatives should be presented on an incremental basis. This means that the costs of the proposed system should appear as zeroes in appropriate columns of summary tables and costs of the other alternative systems should appear as cost differences, with any negative values enclosed in parentheses. The environmental costs are not incremental, and the tabulations should therefore show these as total costs, whether monetized or not. (If an environmental effect is considered beneficial, the entry should be enclosed in parentheses.)

In addition to the information displayed in the tables, the applicant should provide a textual description of the process by which the tradeoffs were weighed and balanced in arriving at the proposed design. This discussion may include any factors not provided for in the tabulation.

10.1 Circulating System (exclusive of intake and discharge)

The applicant should identify and describe alternatives to the proposed cooling system design. Estimates of environmental effects should be prepared and tabulated. Where cooling towers are discussed, the analysis should include variations in drift and blowdown and optional control ranges that might minimize the environmental impact to the receiving air, water, or land with respect to time or space.

10.2 Intake System

The applicant should identify and describe alternatives to the proposed intake system design. Estimates of environmental effects should be prepared and tabulated. Alternatives should be referenced to any requirements for intake systems imposed under PL 92-500.

- Cost of modification or alteration of any other plant system if required for accommodation of alternatives to maintain plant capacity (see item b above)
- Maintenance costs for the transmission facility (if applicable)
- Cost of supplying makeup power during a delay resulting from an alternative design choice which will not meet the power requirement by the scheduled inservice date

e. **Environmental costs.** Environmental effects of alternatives should be fully documented. 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 comparison to the effects of the subsystem chosen for the proposed design. In either case, the derivation of the evaluations should be completely documented.

Table 4 presents a set of environmental factors which should be considered in comparing alternative plant systems in the cost-effectiveness analysis. Although incomplete, the factors listed are believed to represent the principal environmental effects of power plant construction and operation that can be evaluated by generally accepted techniques. The table provides for three key elements of environmental cost evaluation:

1. A description of each effect to be measured (column 3).
2. Suggested units to be used for measurement (column 4). The AEC recognizes the difficulty, if not the impossibility, of using the assigned units for every item in Table 4 in each case, given the current state of the art. The applicant may elect to use other units, provided they are meaningful to the informed public and adequately reflect the impact of the listed environmental effects.
3. A suggested methodology of computation (column 5). Computation of effects in response to each block in Table 4, e.g., 1.1, 1.2, etc., should be given without adjustment for effects computed in other blocks for the same population or resource affected. However, provision is made in Table 4 (i.e., 1.9 and 4.9) to account for combined effects that may be either less than or greater than the sum of individual effects.

In discussing environmental effects, the applicant should specify not only the magnitude of the effect (e.g., pounds of fish killed or acres of a particular habitat destroyed) but also the relative effect, that is, the fraction of the population or resource that is affected. See discussion in Section 5.7.

In some specific cases, accurate estimation of an effect which the applicant believes to be very small may require a data collection effort that would not be commensurate with the value of the information to be obtained. In such cases, the applicant may substitute a preferred measure which conservatively estimates environmental costs for the effect in question, provided the substituted measure is clearly documented and realistically evaluates the potentially detrimental (i.e., worst case) aspects of the effect, and provided the measure is applied consistently to all alternatives.

f. **Supporting details.** In the following subsections, the applicant should discuss design alternatives for each of the relevant plant systems (i.e., cooling system, intake system, etc.). The discussion should describe each alternative, should present estimates of its environmental impact, and should compare the estimated impact with that of the proposed system. The assumptions and calculations on which the estimates are based should be presented. Engineering design and supporting studies, e.g., thermal modeling, performed to assess the impact of alternative plant systems should be limited in scope to those efforts required to support the cost-effectiveness analysis that led to selection of the proposed design.

g. **Presentation of alternative designs.** The results should be tabulated for each plant system in a format consistent with the utilization of the definitions in Table 4.

The monetized costs of the proposed systems and alternatives should be presented on an incremental basis. This means that the costs of the proposed system should appear as zeroes in appropriate columns of summary tables and costs of the other alternative systems should appear as cost differences, with any negative values enclosed in parentheses. The environmental costs are *not* incremental, and the tabulations should therefore show these as total costs, whether monetized or not. (If an environmental effect is considered beneficial, the entry should be enclosed in parentheses.)

In addition to the information displayed in the tables, the applicant should provide a textual description of the process by which the tradeoffs were weighed and balanced in arriving at the proposed design. This discussion may include any factors not provided for in the tabulation.

10.1 Circulating System (exclusive of intake and discharge)

The applicant should identify and describe alternatives to the proposed cooling system design. Estimates of environmental effects should be prepared and tabulated. Where cooling towers are discussed, the analysis should include variations in drift and blowdown and o[illegible]onal control ranges that might minimize the environmental impact to the receiving air, water, or land with respect to time or space.

10.2 Intake System

The applicant should identify and describe alternatives to the proposed intake system design. Estimates of environmental effects should be prepared and tabulated. Alternatives should be referenced to any requirements for intake systems imposed under PL 92-500.

10.3 Discharge System

The applicant should identify and describe alternatives to the proposed discharge system design. Estimates of environmental effects should be prepared and tabulated. Appropriate graphic illustrations of visible plumes or hydraulic mixing zones (air or water as applicable) should be included.

10.4 Chemical Waste Treatment

Alternative chemical systems that meet EPA effluent guidelines but involve differing external environmental impacts associated with ultimate waste disposal of end products should be evaluated. Management of corrosion and resulting corrosion products released with cooling tower blowdown should be treated in detail. The description should include specification of both maximum and average concentrations and dilution sources. (If a discharge is not continuous, the discharge schedule should be specified.) Any toxicity and lethality to affected biota should be documented for all potential points of exposure. Specifically, information should be sufficient to define the impacts to entrained organisms at their points of exposure, as well as the impacts beyond the point of discharge. Estimates of environmental effects should be prepared and tabulated.

10.5 Biocide Treatment

The applicant should describe alternatives to the use of biocide for control of fouling organisms, including both mechanical and chemical methods where such alternatives may be expected to have less severe environmental effects than the proposed system. The information provided on chemical biocides should be similar to that specified above for chemical effluent treatment. Estimates of environmental effects should be prepared and tabulated.

10.6 Sanitary Waste System

Alternative sanitary waste systems which meet EPA guidelines for municipal waste treatment should be identified and discussed with regard to the environmental implications of both waste products and chemical additives for waste treatment. Estimates of environmental effect on receiving land, water, and air should be considered and tabulated to the extent that measurable effects can be identified.

10.7 Liquid Radwaste Systems

For proposed light-water-cooled reactor installations in which the quantities of radioactive material in effluents will be limited to levels that are within the numerical guides for design objectives and limiting conditions of operation set forth in the Commission's proposed amendments (dated February 20, 1974) to 10 CFR Part 50 and embodied in a new Appendix I,[39] no further consideration need be given to the reduction of radiological impacts in formulating alternative plant designs. If the reactor is not a light-water-cooled reactor, the possibility must be explored of an alternative radwaste system that reduces the level of radioactivity in the effluents and direct radiation to the levels proposed in Appendix I. In any case, for reactors to which the proposed Appendix I does not apply, the applicant should demonstrate sufficient consideration of alternative radwaste systems and of their radiological output to assure that releases from the proposed facility will be as low as practicable.

10.8 Gaseous Radwaste Systems

Consideration of systems for the disposal of gaseous radwaste is subject to the qualifying condition noted in Section 10.7 above.

10.9 Transmission Facilities

The applicant should discuss the cost and environmental effects of alternative routes for new transmission facilities required for tie-in of the proposed facility to the applicant's system. The documentation should include maps of the alternative routes. These maps should clearly indicate topographic features important to evaluation of the routes and boundaries of visually sensitive areas. The applicant may find the documents cited in Section 3.9 helpful in this analysis. Estimates of environmental effects should be prepared and tabulated.

10.10 Other Systems

Any plant system, other than those specified above, that is associated with an adverse environmental effect should be discussed in terms of practicable and feasible alternatives that may reduce or eliminate this environmental effect.

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[39] "Final Environmental Statement Concerning Proposed Rule-Making Action: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," WASH-1258, Vol. 1, pp. 1A-3 to 1A-5, prepared by the Directorate of Regulatory Standards, U.S. Atomic Energy Commission, Washington, D.C. 20545.

CHAPTER 11

SUMMARY BENEFIT-COST ANALYSIS

This chapter should demonstrate through a benefit-cost analysis of the proposed plant why in the applicant's judgment the aggregate benefits outweigh the aggregate costs. The Commission will independently prepare a cost-benefit analysis of the proposed plant in the Environmental Statement; nevertheless, the applicant should perform his own analysis in order to aid the Commission in its evaluation.

Although the benefit-cost analysis approach discussed in this guide is conceptually similar to the benefit-cost approach classically employed in a purely economic context, the method recommended differs from it procedurally. This is because the benefits and costs to be evaluated will not all be monetized by the applicant. The incommensurable nature of the benefits and costs makes it virtually impossible to provide a concise assessment of benefits vs. costs 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 basis that is consistent with the underlying concept of benefit-cost analysis.

The following considerations may be helpful to the applicant in preparing the analysis. As indicated above, it is incumbent on the applicant to demonstrate that the benefits of the proposed facility are considered to outweigh the aggregate costs. Beyond this, the degree to which the benefits may outweigh the costs is a factor which will be considered in the Commission's "Environmental Statement." In selecting each proposed plant system from a set of alternative systems, the cost-effectiveness analysis of Chapter 10 will have maximized the net benefit (i.e., aggregate of benefits minus the costs).

In presenting the cost-benefit analysis, the applicant should first consider the benefits identified and described in Chapters 1 and 8. Secondly, generating, environmental, and other cost items identified in Chapters 4, 5, 8, and 10 should be considered; these costs should be summarized in tabular form.

CHAPTER 12

ENVIRONMENTAL APPROVALS AND CONSULTATION

List and give the status of all licenses, permits, and other approvals of plant construction and operations required by Federal, State, local, and regional authorities for the protection of the environment.

List all laws or ordinances applicable to the proposed transmission system and the status of approvals that must be obtained. Indicate any public hearings held or to be held with respect to the proposed transmission system.

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

Discuss the status of efforts to obtain a water quality certification under Section 401 and discharge permits under Section 402, of the Federal Water Pollution Control Act, as amended. If certification has not already been obtained, indicate when it is expected. If certification is not required, explain. Any other actions such as a pending request based on Section 316(a) of Public Law 92-500 for effluents limitation or standards modification should be explained.

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

In view of the effects of the plant on the economic development of the region in which it is located, the applicant should also note the State, local, and regional planning authorities contacted or consulted. OMB Circular A-95[40] identifies the State, metropolitan, and regional clearinghouses that should be contacted as appropriate. (A listing of the clearinghouses that serve a particular site area may be obtained from the NRC.)

Where consumptive water uses involve permits or adjudication, applicants should show evidence of such with respect to State, Federal, or Compact or Commission authorities having purview over the proposed diversion.

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[40] Inquiries concerning this circular may be addressed to the Office of Management and Budget, Washington, D.C. 20503.

CHAPTER 13
REFERENCES

The applicant should provide a bibliography of sources used in preparation of the environmental report.

References cited should be keyed to the specific chapters to which they apply.

TABLE 1

SUMMARY OF ENVIRONMENTAL CONSIDERATIONS FOR URANIUM FUEL CYCLE
(from 10 CFR Part 51, §51.20)
(Normalized to model LWR annual fuel requirement)

Natural resource use	Total	Maximum effect per annual fuel requirement of model 1,000 MWe LWR
Land (acres):		
Temporarily committed	63	
Undisturbed area	45	
Disturbed area	18	Equivalent to 90 MWe coal-fired powerplant
Permanently committed	4.6	
Overburden moved (millions of MT)	2.7	Equivalent to 90 MWe coal-fired powerplant
Water (millions of gallons):		
Discharged to air	156	≈ 2 percent model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,040	
Discharged to ground	123	
Total	11,319	<4 percent of model 1,000 MWe LWR with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of MW-hour)	317	<5 percent of model 1,000 MWe LWR output.
Equivalent coal (thousands of MT)	115	Equivalent to the consumption of a 45-MWe coal-fired powerplant.
Natural gas (millions of scf)	92	<0.2 percent of model 1,000 MWe energy output
Effluents – chemical (MT):		
Gases (including entrainment):[a]		
SO_x	4,400	
NO_x[b]	1,177	Equivalent to emissions from 45-MWe coal-fired plant for a year.
Hydrocarbons	13.5	
CO	28.7	
Particulates	1,156	
Other gases:		
F^-	0.72	Principally from UF_6 production enrichment and reprocessing. Concentration within range of state standard–below level that has effects on human health.
Liquids:		
SO_4^-	10.3	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are:
NO_3^-	26.7	NH_3 – 600 cfs
Fluoride	12.9	NO_3 – 20 cfs
Ca^{++}	5.4	Fluoride – 70 cfs
Cl^-	8.6	
Na^+	16.9	
NH_3	11.5	
Fe	0.4	

(continued)

TABLE 1 (continued)

Natural resource use	Total	Maximum effect per annual fuel requirement of model 1,000 MWe LWR
Tailings solutions (thousands of MT)	240	From mills only – no significant effluents to environment.
Solids	91,000	Principally from mills – no significant effluents to environment.
Effluents – Radiological (curies):		
Gases (including entrainment):		
Rn-222	75	Principally from mills – maximum annual dose rate <4 percent of average natural background within 5 mi of mill. Results in 0.06 man-rem per annual fuel requirement.
Ra-226	0.02	
Th-230	0.02	
Uranium	0.032	
Tritium (thousand)	16.7	Principally from fuel reprocessing plants – Whole body dose is 4.4 man-rem per annual fuel requirements for population within 50 mi radius. This is <0.005 percent of average natural background dose to this population. Release from Federal Waste Repository of 0.005 Ci/yr has been included in fission products and transuranics total.
Kr-85 (thousands)	350	
I-129	0.0024	
I-131	0.024	
Fission products and transuranics	1.01	
Liquids:		
Uranium and daughters	2.1	Principally from milling – included in tailings liquor and returned to ground – no effluents; therefore, no effect on environment.
Ra-226	0.0034	From UF_6 production-concentration 5 percent of 10 CFR Part 20 for total processing of 27.5 model LWR annual fuel requirements.
Th-230	0.0015	
Th-234	0.01	From fuel fabrication plants – concentration 10 percent of 10 CFR Part 20 for total processing 26 annual fuel requirements for model LWR.
Ru-106	0.15[c]	From reprocessing plants – maximum concentration 4 percent of 10 CFR Part 20 for total reprocessing of 26 annual fuel requirements for model LWR.
Tritium (thousands)	2.5	
Solids (buried):		
Other than high level	601	All except 1 Ci comes from mills – included in tailings returned to ground – no significant effluent to the environment, 1 Ci from conversion and fuel fabrication is buried.
Thermal (billions)	3,360	<7 percent of model 1,000 MWe LWR.
Transportation (man-rem):		
Exposure of workers and general public	0.334	

[a]Estimated effluents based upon combustion of equivalent coal for power generation.
[b]1.2 percent from natural gas use and process.
[c]Cs-137 (0.075 Ci/AFR) and Sr-90 (0.004 Ci/AFR) are also emitted.

TABLE 2

PRIMARY[a] BENEFITS TO BE CONSIDERED IN COST-BENEFIT ANALYSIS

Direct Benefits

Expected average annual generation in kWh . . . .
Capacity in kW . . . .
Proportional distribution of electrical energy
(Expected annual delivery in kWh)
Industrial . . . .
Commercial . . . .
Residential . . . .
Other . . . .

Expected average annual Btu (in millions) of steam sold from the facility . . . .
Expected average annual delivery of other beneficial products (appropriate physical units) . . . .
Annual revenues from delivered benefits:
Electrical energy generated. . . . .
Steam sold . . . .
Other products. . . . .

Indirect Benefits (as appropriate)

Taxes (local, State, Federal) . . . .
Research . . . .
Regional product. . . . .
Environmental enhancement:
Recreation . . . .
Navigation . . . .
Air Quality:
SO_2 . . . .
NO_x . . . .
Particulates . . . .
Others . . . .
Employment . . . .
Education . . . .
Others . . . .

[a]See Section 8.1

TABLE 3

MONETIZED BASES FOR GENERATING COSTS[a]

Item	Symbol	Unit	Item Description
Total outlay required to bring facility to operation	C_I	$	All capital outlays including interest expense to be invested in completion of the facility compounded to present value as of the scheduled inservice date of operation.
Annual operating cost	O_t	$	This is the total operating and maintenance cost of plant operation in year t.
Annual fuel cost	F_t	$	This is the total fuel cost in year t.
Cost of makeup power purchased or supplied in year t	P_t	$	Cost of power purchased or supplied internally in year t to make up deficiency of power associated with any alternative which introduces delay.[b]
Discount factor	ν		$\nu = (1 + i)^{-1}$ where i is the applicant's estimated average cost of capital over the life of this plant.
Total generating cost–present value	GC_p	$	$GC_p = C_I + \sum_{t=1}^{30} \nu^t (O_t + F_t) + \sum_{t=1}^{30} \nu^t P_t$
Total generating cost–present value annualized	GC_a	$	$GC_a = GC_p \times \frac{i(1 + i)^{30}}{(1 + i)^{30} - 1}$

[a]For conventional (nuclear or fossil fuel) steam-electric plants.
[b]Delay to be computed from the time of filing for a construction permit (10 CFR Part 51, § 51.20)

TABLE 4 (continued)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
4.7 Transmission line operation	4.7.1 Land Use	Land preempted by right-of-way may be used for additional beneficial purposes such as orchards, picnic areas, nurseries, hiking and riding trails.	%, dollars.	Estimate percent of right-of-way for which no multiple use activities are planned. Annual value of multiple use activities less cost of improvements.
	4.7.2 Wildlife	Modified wildlife habitat may result in changes.	Qualified opinion.	Summarize qualified opinion including views of cognizant local and State wildlife agencies when available.
4.8 Other land impacts				The applicant should describe and quantify any other environmental effects of the proposed plant which are significant.
4.9 Combined or interactive effects				Where evidence indicates that the combined effects of a number of impacts on a particular population or resource are not adequately indicated by measures of the separate impacts, the total combined effect should be described. Both beneficial and adverse interactions should be indicated.
4.10 Net effects				See discussion in Section 5.7.

APPENDIX 1
DATA RETRIEVAL SYSTEM (PROPOSED)

With a view toward improving the usability of data presented by applicants, an outline format for a standardized data retrieval system for storage in a computer center is planned as an Appendix in a future revision of this guide. Specific use categories will be developed for the following guide outline topics:

Data Categories

1.0 Station purpose
- 1.1 Demand analysis
- 1.2 Energy conservation
- 1.3 Reserve margins
- 1.4 Supporting references

2.0 Site and resource interfaces summaries
- 2.1 Geography and demography
- 2.2 Ecology
- 2.3 Meteorology and climatology
- 2.4 Hydrology
- 2.5 Geology
- 2.6 Aesthetic and cultural data

3.0 Station and unit data summaries
- 3.1 Building and grounds data
- 3.2 Reactor and steam-electric system
- 3.3 Water use
- 3.4 Heat dissipation
- 3.5 Radiation data
- 3.6 Chemical effluent
- 3.7 Sanitary waste data
- 3.8 Transportation data
- 3.9 Electrical transmission

6.0 Preoperational program summary

8.0 Socioeconomic data summary

9.0 Cost-benefit summary

10.0 Design alternatives summary

12.0 Permit and certification summary

13.0 Reference list

APPENDIX 2

DATA NEEDED FOR RADIOACTIVE SOURCE TERM CALCULATIONS FOR PRESSURIZED WATER REACTORS

The applicant should provide the types of information listed in this appendix. The information should be taken from the contents of the safety analysis report and the environmental report of the proposed pressurized water reactor. The appropriate sections of the SAR and ER that contain a more detailed discussion of the required information should be referenced. This information constitutes the basic data required in calculating the releases of radioactive material in liquid and gaseous effluents (the source terms).

1. The source term model used in the calculation of radioactive source terms (give reference) and the values used for the following parameters:
   a. Plant capacity factor.
   b. Fraction of fuel releasing radioactivity in the primary coolant (indicate the type of fuel cladding).
   c. Fission product escape rate coefficients.
   d. Corrosion product release rate coefficients.
   e. Tritium release rate (Ci/yr).
2. The maximum core thermal power (MWt) evaluated for safety considerations in the SAR. (Note: All of the following responses should be adjusted to this power level.)
3. The total mass (lb) of coolant in the primary system excluding the pressurizer and primary coolant purification system.
4. The total mass (lb) of uranium and plutonium in an equilibrium core (metal weight).
5. The percent enrichment of uranium in reload fuel.
6. The percent of fissile plutonium in reload fuel.
7. The average primary system letdown rate (gpm) to the primary coolant purification system.
8. The average flow rate (gpm) through the primary coolant purification system cation demineralizers. (Note: The letdown rate should include the fraction of time the cation demineralizers are in service.) If cation demineralizers are not used, describe the method employed for controlling cesium and lithium concentrations in the primary coolant purification system; include the average flow rate assumed for cesium and lithium control.
9. The number and type of steam generators and the carryover factor used in your evaluation for iodine and nonvolatiles.
10. The total steam flow (lb/hr) in the secondary system.
11. The mass of steam in each steam generator (lb).
12. The mass of liquid in each steam generator (lb).
13. The total mass of coolant in the secondary system (lb). For recirculating U-tube steam generators, do not include the coolant in the condenser hotwell.
14. The average total steam generator blowdown rate (gpm).
15. The regeneration frequency (days) for the condensate demineralizers. The type of resins used (deep-bed demineralizers or Powdex filter/demineralizers).
16. The fraction of the steam generator feedwater processed through the condensate demineralizers and the DFs used in your evaluation of the condensate demineralizer system.
17. The flow rate (gpm) of water used to dilute liquid waste prior to discharge.
18. The average shim bleed flow (gpm).
19. System description of the process used for shim bleed. A process flow diagram of the system indicating all of the decontamination factors considered in your evaluation.
20. The shim bleed holdup times considered in your evaluation for collection, processing, and discharge. The fraction of the processed stream expected to be discharged over the life of the plant. The capacities (gal) of all tanks considered in calculating the holdup times.
21. The sources, flow rate (gpd), and expected activities (fraction of primary coolant activity, PCA) of any other wastes which are processed with the shim bleed.
22. Description of the system used to process the wastes identified in Item 21. Identify the differences between the processing of these waters and the shim bleed. Provide the DFs used in your evaluation.
23. The holdup times used in your evaluation for the collection, processing, and discharge of the wastes indicated in Item 21. The fraction of the processed stream expected to be discharged over the life of the plant. Provide the tank capacities (gal) and flow rates (gpd) used in your evaluation.
24. The input sources, average flow rates (gpd), and activities (fraction of PCA) of wastes processed through the clean waste system.
25. Description of the system used to process the clean wastes. The process flow diagram for the clean waste system, indicating all of the decontamination factors used in your evaluation.
26. The clean waste holdup times used in your evaluation and the fraction of the processed stream expected to be discharged over the life of the plant. The capacities (gal) of all tanks considered in calculating the holdup times.
27. The sources, flow rates (gpd), and activities (fraction of PCA) of wastes processed through the dirty waste system.
28. Description of the system used to process the dirty wastes. A process flow diagram for the dirty waste system, indicating all of the decontamination factors used in your evaluation.
29. The dirty waste holdup times used in your evaluation. The fraction of the processed stream expected to be discharged over the life of the plant. The capacities

APPENDIX 2

DATA NEEDED FOR RADIOACTIVE SOURCE TERM CALCULATIONS FOR PRESSURIZED WATER REACTORS

The applicant should provide the types of information listed in this appendix. The information should be taken from the contents of the safety analysis report and the environmental report of the proposed pressurized water reactor. The appropriate sections of the SAR and ER that contain a more detailed discussion of the required information should be referenced. This information constitutes the basic data required in calculating the releases of radioactive material in liquid and gaseous effluents (the source terms).

1. The source term model used in the calculation of radioactive source terms (give reference) and the values used for the following parameters:
   a. Plant capacity factor.
   b. Fraction of fuel releasing radioactivity in the primary coolant (indicate the type of fuel cladding).
   c. Fission product escape rate coefficients.
   d. Corrosion product release rate coefficients.
   e. Tritium release rate (Ci/yr).
2. The maximum core thermal power (MWt) evaluated for safety considerations in the SAR. (Note: All of the following responses should be adjusted to this power level.)
3. The total mass (lb) of coolant in the primary system excluding the pressurizer and primary coolant purification system.
4. The total mass (lb) of uranium and plutonium in an equilibrium core (metal weight).
5. The percent enrichment of uranium in reload fuel.
6. The percent of fissile plutonium in reload fuel.
7. The average primary system letdown rate (gpm) to the primary coolant purification system.
8. The average flow rate (gpm) through the primary coolant purification system cation demineralizers. (Note: The letdown rate should include the fraction of time the cation demineralizers are in service.) If cation demineralizers are not used, describe the method employed for controlling cesium and lithium concentrations in the primary coolant purification system; include the average flow rate assumed for cesium and lithium control.
9. The number and type of steam generators and the carryover factor used in your evaluation for iodine and nonvolatiles.
10. The total steam flow (lb/hr) in the secondary system.
11. The mass of steam in each steam generator (lb).
12. The mass of liquid in each steam generator (lb).
13. The total mass of coolant in the secondary system (lb). For recirculating U-tube steam generators, do not include the coolant in the condenser hotwell.
14. The average total steam generator blowdown rate (gpm).
15. The regeneration frequency (days) for the condensate demineralizers. The type of resins used (deep-bed demineralizers or Powdex filter/demineralizers).
16. The fraction of the steam generator feedwater processed through the condensate demineralizers and the DFs used in your evaluation of the condensate demineralizer system.
17. The flow rate (gpm) of water used to dilute liquid waste prior to discharge.
18. The average shim bleed flow (gpm).
19. System description of the process used for shim bleed. A process flow diagram of the system indicating all of the decontamination factors considered in your evaluation.
20. The shim bleed holdup times considered in your evaluation for collection, processing, and discharge. The fraction of the processed stream expected to be discharged over the life of the plant. The capacities (gal) of all tanks considered in calculating the holdup times.
21. The sources, flow rate (gpd), and expected activities (fraction of primary coolant activity, PCA) of any other wastes which are processed with the shim bleed.
22. Description of the system used to process the wastes identified in Item 21. Identify the differences between the processing of these waters and the shim bleed. Provide the DFs used in your evaluation.
23. The holdup times used in your evaluation for the collection, processing, and discharge of the wastes indicated in Item 21. The fraction of the processed stream expected to be discharged over the life of the plant. Provide the tank capacities (gal) and flow rates (gpd) used in your evaluation.
24. The input sources, average flow rates (gpd), and activities (fraction of PCA) of wastes processed through the clean waste system.
25. Description of the system used to process the clean wastes. The process flow diagram for the clean waste system, indicating all of the decontamination factors used in your evaluation.
26. The clean waste holdup times used in your evaluation and the fraction of the processed stream expected to be discharged over the life of the plant. The capacities (gal) of all tanks considered in calculating the holdup times.
27. The sources, flow rates (gpd), and activities (fraction of PCA) of wastes processed through the dirty waste system.
28. Description of the system used to process the dirty wastes. A process flow diagram for the dirty waste system, indicating all of the decontamination factors used in your evaluation.
29. The dirty waste holdup times used in your evaluation. The fraction of the processed stream expected to be discharged over the life of the plant. The capacities

(gal) of all tanks considered in calculating the holdup times.

30. Description of the system used to maintain secondary coolant purity, e.g., steam generator blowdown. The primary-to-secondary-system leakage rate (gpd) used in your evaluation. The parameters used for steam generator blowdown rate (gpm) or condensate demineralizer regenerant wastes volumes (gpd).

31. Description of the system used to process the secondary system wastes, e.g., the steam generator blowdown purification system or regenerant waste treatment system. A process flow diagram for the system, indicating all of the decontamination factors used.

32. The holdup times used in calculating releases from the secondary system. The fraction of the processed waste stream expected to be discharged over the life of the plant. The capacities (gal) of all tanks considered in the calculation of the holdup times.

33. Description of the process used for stripping fission gases from the primary coolant. The average continuous gas stripping rate (gpm). The number of primary coolant volumes stripped for cold reactor shutdown. Indicate whether the reactor will operate in a base-load or load-follow mode.

34. Description of the process used to hold up gases for normal operations and for shutdown strippings from the primary system. A process flow diagram of the system, indicating the capacities (ft^3), number, and design and operating storage pressures for pressurized storage tanks.

35. The volumes (ft^3/yr) of gases stripped from the primary coolant.

36. Description of the normal operation of the waste gas processing system, e.g., number of tanks held in reserve for back-to-back shutdown, fill time for tanks. The minimum holdup time used in your evaluation.

37. The primary coolant leakage rate (lb/day) to the auxiliary building used in your evaluation. The temperature of the primary coolant in the letdown line as it enters the auxiliary building. The iodine partition factor used in calculating releases from the auxiliary building.

38. Description of the treatment provided for auxiliary building ventilation air to reduce iodine prior to discharge. The decontamination factor for the charcoal adsorber used in your evaluation.

39. The total free volume (ft^3) of the containment building.

40. Description of the system used to reduce airborne radioactivity from the containment building atmosphere prior to personnel entry and purging of the containment. The recirculation rate (10^3 cfm), operating time of the internal cleanup system, the bed depth and decontamination factor of the charcoal adsorbers, and the mixing efficiency used in your evaluation.

41. State the number of containment purges per year. If containment ventilation air is purged through charcoal adsorbers, provide the bed depth and the iodine decontamination factor. Primary coolant leak rate to the containment building used in your evaluation.

42. Description of special design features used to reduce steam leakage to the turbine building and the leakage rate used in your evaluation.

43. Description of the treatment system used to reduce gaseous iodine releases from the steam generator blowdown flash tank and the fraction of iodine released through the system vent used in your evaluation.

44. Description of the treatment system to reduce iodine released from the condenser air ejectors and the fraction of iodine released through the system vent used in your evaluation.

45. Inputs to solid waste system: volumes, curie contents, and sources of wastes. Principal radionuclides, onsite storage times prior to shipment. Description of solid waste processing system.

46. Process and instrumentation diagrams for liquid, gaseous, and solid radwaste systems along with all other systems influencing the source term calculations, i.e., primary coolant purification system, steam generator blowdown purification system.

47. Sources, flow rates (gpd), and activities of detergent wastes. Description of treatment process, volumes of holdup tanks, and decontamination factors used in your evaluation.

48. Process and instrumentation diagrams for fuel pool cooling and purification systems and for fuel pool ventilation systems. Provide the volume of fuel pool and refueling canals, identify the source of makeup water, and describe the management of water inventories during refueling. Provide an analysis of the concentrations of radioactive materials in the fuel pool water following refueling, and calculate the releases of radioactive materials in gaseous effluents due to evaporation from the surface of the fuel pool and refueling canals during refueling and during normal power operation. Provide the bases for the values used.

APPENDIX 3

DATA NEEDED FOR RADIOACTIVE SOURCE TERM CALCULATIONS FOR BOILING WATER REACTORS

The applicant is required to provide the types of information listed in this appendix. The information should be taken from the contents of the safety analysis report and the environmental report of the proposed boiling water reactor. The appropriate sections of the SAR and ER that contain a more detailed discussion of the required information should be referenced. This information constitutes the basic data required in calculating the releases of radioactive material in liquid and gaseous effluents (the source terms).

1. The source term model used in the calculation of radioactive source terms (cite reference) and the values used for the following parameters and their bases:
   a. Plant capacity factor.
   b. Isotopic release rates of noble gases to the reactor coolant and at 30 minutes decay (μCi/sec).
   c. Concentrations of fission products in the reactor coolant (μCi/g).
   d. Concentrations of corrosion and activation products in the reactor coolant (μCi/g).
   e. Tritium release rate (Ci/yr).
2. The maximum core thermal power (MWt) evaluated for safety considerations in the SAR (Note: All of the following responses should be adjusted to this power level).
3. The total steam flow (lb/hr).
4. The mass (lb) of primary coolant in the reactor vessel.
5. The average flow rate (gpm) through the reactor coolant cleanup demineralizer. The type of resins used, i.e., deep bed demineralizers or (Powdex) filter/demineralizers. The DFs used for the cleanup demineralizers.
6. The total mass (lb) of uranium and plutonium in an equilibrium core (metal weight).
7. The percent enrichment of uranium in reload fuel.
8. The percent of fissile plutonium in reload fuel.
9. The regeneration frequency (days) for the condensate demineralizers. The type of resins used, i.e., deep bed demineralizers or (Powdex) filter/demineralizers. The DFs used in the evaluation for the condensate demineralizers.
10. The flow rate (gpm) of water used to dilute liquid waste prior to discharge.
11. The input sources, average flow rates (gpd), and activities (fraction of PCA) of wastes processed through the high-purity waste system.
12. Description of the system used to process the high-purity waste. The process flow diagram for the high-purity waste system, indicating all decontamination factors used in the evaluation.
13. The high-purity waste holdup times used in the evaluation and the fraction of the processed stream expected to be discharged over the life of the plant. The capacities (gal) of all tanks considered in calculating the holdup time.
14. The input sources, average flow rates (gpd), and activities (fraction of PCA) of wastes processed through the low-purity waste system.
15. Description of the system used to process the low-purity waste. The process flow diagram for the low-purity waste system, indicating all of the decontamination factors used in the evaluation.
16. The low-purity waste holdup times used in the evaluation and the fraction of the processed stream expected to be discharged over the life of the plant. The capacities (gal) of all tanks considered in calculating the holdup times.
17. The input sources, average flow rates (gpd), and activities (fraction of PCA) of water processed through the chemical waste system.
18. Description of the system used to process the chemical waste. The process flow diagram for the chemical waste system, indicating all decontamination factors used in the evaluation.
19. The chemical waste holdup times used in the evaluation and the fraction of the processed stream expected to be discharged over the life of the plant. The capacities (gal) of all tanks considered in calculating the holdup times.
20. The steam leakage rate (lb/hr) to the turbine building considered in the evaluation. Description of special design features used to reduce steam leakage, and the fraction of iodine released. If ventilation air is treated through charcoal adsorbers, the bed depth and the iodine decontamination factor used.
21. The steam flow (lb/hr) to the turbine gland seal and the source of the steam (nonradioactive steam from an auxiliary boiler, water from the condensate storage, or main steam).
22. The mass (lb) of steam in the reactor vessel.
23. The design holdup time (hr) for gas vented from the gland seal condenser, the iodine partition factor for the condenser, and the fraction of iodine released through the system vent. Description of the treatment system used to reduce iodine releases from the gland seal system.
24. The primary coolant leakage rate (lb/day) to the reactor building, the temperature of the coolant, and the iodine partition factor used in calculating releases from the reactor building in the evaluation.
25. Description of the treatment provided for the reactor building ventilation air to reduce iodine prior to discharge. The decontamination factor and the bed depth of the charcoal adsorber used in the evaluation.
26. The holdup time (hr) for offgases from the main condenser air ejector prior to processing by the offgas treatment system.
27. Description and expected performance of the gaseous waste treatment system of the offgases from the condenser air ejector. The expected air inleakage per

condenser shell, the number of condenser shells, and the iodine partition factor for the condenser.

28. The mass of charcoal in the charcoal delay system used to treat the offgases from the main condenser air ejector, the operating temperature of the delay system, and the dynamic adsorption coefficient for Xe and Kr, based on the system design used in calculating the respective holdup times.

29. Description of cryogenic distillation system, fraction of gases partitioned during distillation, holdup in system, storage following distillation, and expected system leakage.

30. Inputs to the solid waste system: volumes, curie contents, and sources of wastes. Principal radionuclides, onsite storage times prior to shipment. Description of solid waste processing system.

31. Sources, flow rates (gpd), and activities of detergent wastes. Description of treatment process, volumes of holdup tanks, and decontamination factors used in the evaluation.

32. Process and instrumentation diagrams for liquid, gaseous, and solid radwaste systems and all other systems influencing the source term calculations, e.g., primary coolant purification system.

33. Process and instrumentation diagrams for fuel pool cooling and purification systems and for fuel pool ventilation systems. Provide the volume of fuel pool and refueling canals, identify the source of makeup water, and describe the management of water inventories during refueling. Provide an analysis of the concentrations of radioactive materials in the fuel pool water following refueling, and calculate the releases of radioactive materials in gaseous effluents due to evaporation from the surface of the fuel pool and refueling canals during refueling and during normal power operation. Provide the bases for the values used.

APPENDIX 4

EXAMPLES OF CHARTS SHOWING RADIATION EXPOSURE PATHWAYS

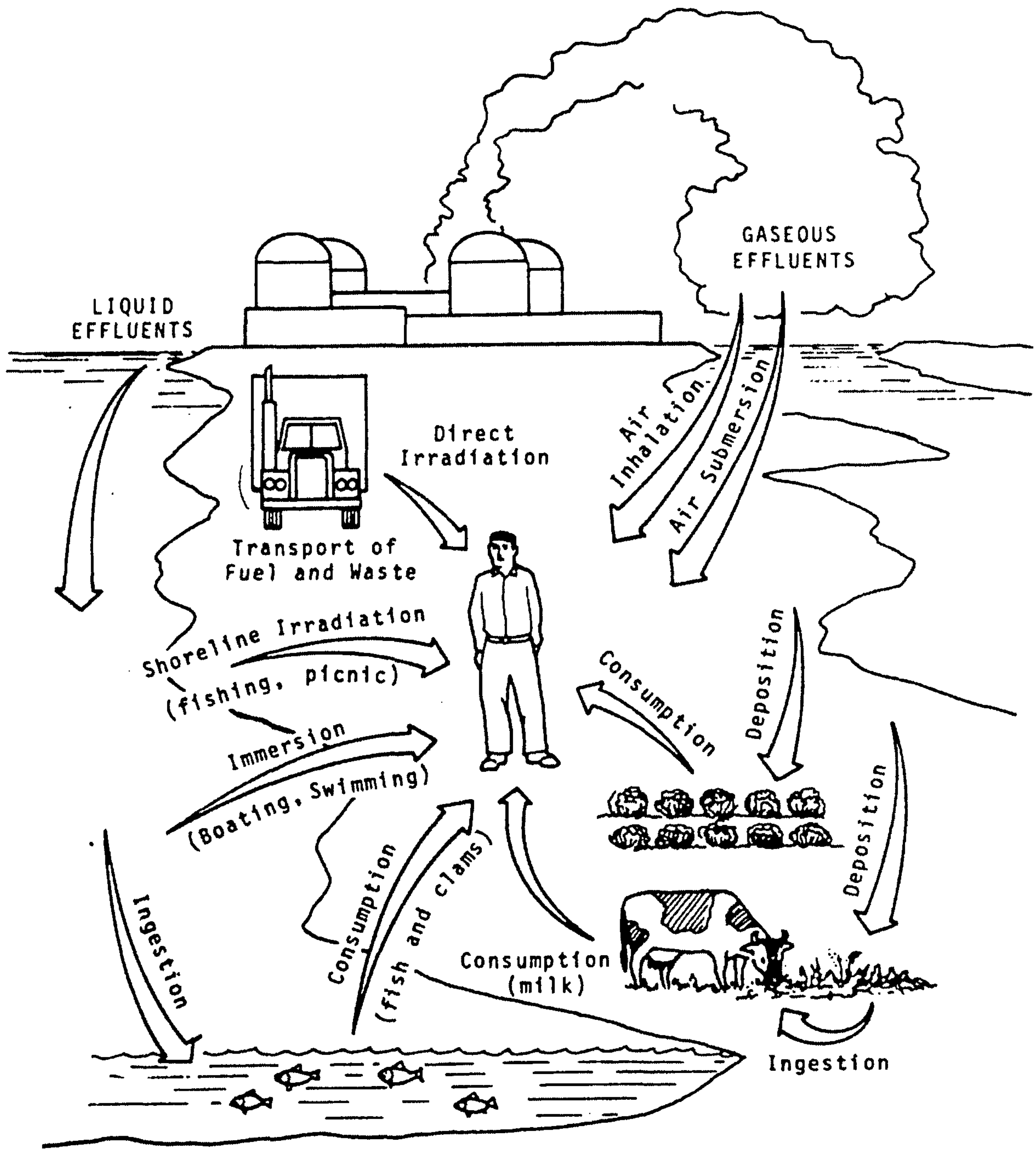

Figure 1. Generalized Exposure Pathways for Man

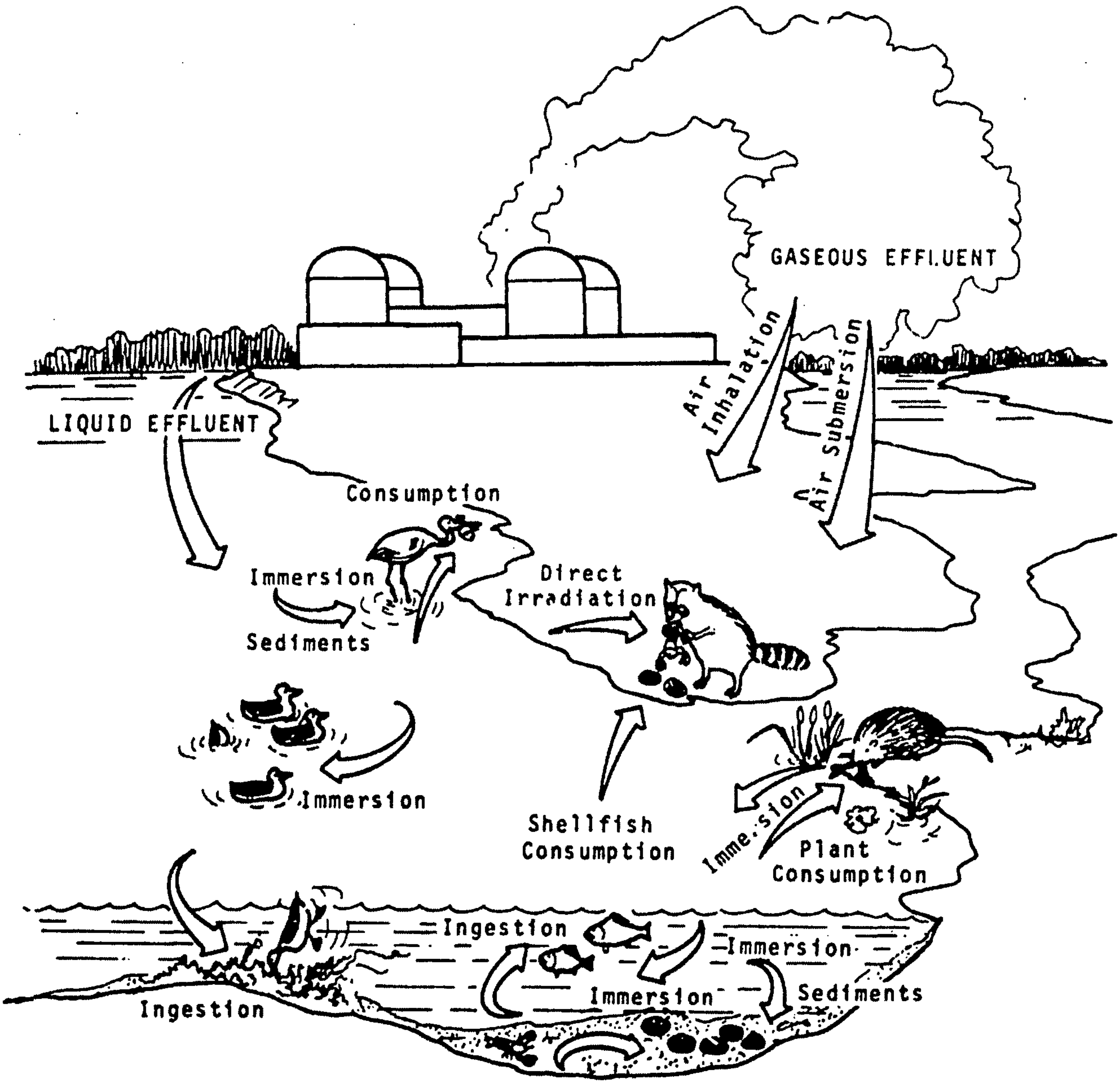

Figure 2. Generalized Exposure Pathways for Organisms Other Than Man

APPENDIX 5

PROPOSED ANNEX TO APPENDIX D, 10 CFR PART 50

DISCUSSION OF ACCIDENTS IN APPLICANTS' ENVIRONMENTAL REPORTS: ASSUMPTIONS

"This Annex requires certain assumptions to be made in discussion of accidents in Environmental Reports submitted pursuant to Appendix D by applicants[1] for construction permits or operating licenses for nuclear power reactors.[2]

"In the consideration of the environmental risks associated with the postulated accidents, the probabilities of their occurrence and their consequences must both be taken into account. Since it is not practicable to consider all possible accidents, the spectrum of accidents, ranging in severity from trivial to very serious, is divided into classes.

"Each class can be characterized by an occurrence rate and a set of consequences.

"Standardized examples of classes of accidents to be considered by applicants in preparing the section of Environmental Reports dealing with accidents are set out in tabular form below. The spectrum of accidents, from the most trivial to the most severe, is divided into nine classes, some of which have subclasses. The accidents stated in each of the eight classes in tabular form below are representative of the types of accidents that must be analyzed by the applicant in Environmental Reports; however, other accident assumptions may be more suitable for individual cases. Where assumptions are not specified, or where those specified are deemed unsuitable, assumptions as realistic as the state of knowledge permits shall be used, taking into account the specific design and operational characteristics of the plant under consideration.

"For each class, except Classes 1 and 9, the environmental consequences shall be evaluated as indicated. Those classes of accidents, other than Classes 1 and 9, found to have significant adverse environmental effects shall be evaluated as to probability, or frequency of occurrence to permit estimates to be made of environmental risk or cost arising from accidents of the given class.

"Class 1 events need not be considered because of their trivial consequences.

[1] Although this annex refers to applicants' Environmental Reports, the current assumptions and other provisions thereof are applicable, except as the content may otherwise require, to AEC draft and final Detailed Statements.

[2] Preliminary guidance as to the content of applicants' Environmental Reports was provided in the Draft AEC Guide to the Preparation of Environmental Reports for Nuclear Power Plants dated February 19, 1971, a document made available to the public as well as to the applicant. Guidance concerning the discussion of accidents in environmental reports was provided to applicants in a September 1, 1971, document entitled "Scope of Applicants' Environmental Reports with Respect to Transportation, Transmission Lines, and Accidents," also made available to the public.

"Class 8 events are those considered in safety analysis reports and AEC staff safety evaluations. They are used, together with highly conservative assumptions, as the design-basis events to establish the performance requirements of engineered safety features. The highly conservative assumptions and calculations used in AEC safety evaluations are not suitable for environmental risk evaluation, because their use would result in a substantial overestimate of the environmental risk. For this reason, Class 8 events shall be evaluated realistically, Consequences predicted in this way will be far less severe than those given for the same events in safety analysis reports where more conservative evaluations are used.

"The occurrences in Class 9 involve sequences of postulated successive failures more severe than those postulated for establishing the design basis for protective systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture, and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain, sufficiently remote in probability that the environmental risk is extremely low. For these reasons, it is not necessary to discuss such events in applicants' Environmental Reports.

"Furthermore, it is not necessary to take into account those Class 8 accidents for which the applicant can demonstrate that the probability has been reduced and thereby the calculated risk to the environment made equivalent to that which might be hypothesized for a Class 9 event.

"Applicant may substitute other accident class breakdowns and alternative values of radioactive material releases and analytical assumptions, if such substitution is justified in the Environmental Report."

ACCIDENT ASSUMPTIONS
TABLE OF CONTENTS

4.0 Fission products to primary system (BWR).

4.1 Fuel cladding defects.

4.2 Off-design transients that induce fuel failures above those expected.

5.0 Fission products to primary and secondary systems (PWR).

5.1 Fuel cladding defects and steam generator leaks.

5.2 Off-design transients that induce fuel failure above those expected and steam generator leak.

5.3 Steam generator tube rupture.

6.0 Refueling accidents.

6.1 Fuel bundle drop.

6.2 Heavy object drop onto fuel in core.

7.0 Spent fuel handling accident.

7.1 Fuel assembly drop in fuel storage pool.

7.2 Heavy object drop onto fuel rack.

7.3 Fuel cask drop.

8.0 Accident initiation events considered in design basis evaluation in the safety analysis report.

8.1 Loss-of-coolant accidents.

8.1(a) Break in instrument line from primary system that penetrates the containment.

8.2(a) Rod ejection accident (PWR).

8.2(b) Rod drop accident (BWR).

8.3(a) Steamline breaks (PWRs outside containment).

8.3(b) Steamline breaks (BWR).

ACCIDENT ASSUMPTIONS

ACCIDENT–1.0 TRIVIAL INCIDENTS

These incidents shall be included and evaluated under routine releases in accordance with proposed Appendix I.[1]

ACCIDENT–2.0 SMALL RELEASE OUTSIDE CONTAINMENT

These releases shall include such things as releases through steamline relief valves and small spills and leaks of radioactive materials outside containment. These releases shall be included and evaluated under routine releases in accordance with proposed Appendix I.

ACCIDENT–3.0 RADWASTE SYSTEM FAILURE

3.1 *Equipment leakage or malfunction* (includes operator error).

(a) Radioactive gases and liquids: 25% of average inventory in the largest storage tank shall be assumed to be released.

(b) Meteorology assumptions–χ/Q values are to be 1/10 of those given in AEC Safety Guide No. 3 or 4.[2]

(c) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

3.2 *Release of waste gas storage tank contents* (includes failure of release valve and rupture disks).

(a) 100% of the average tank inventory shall be assumed to be released.

(b) Meteorology assumptions: χ/Q values shall be 1/10 of those given in Safety Guide No. 3 or 4.

(c) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

3.3 *Release of liquid waste storage tank contents*

(a) Radioactive liquids: 100% of the average storage tank inventory shall be assumed to be spilled on the floor of the building.

(b) Building structure shall be assumed to remain intact.

(c) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3 or 4.

(d) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

ACCIDENT–4.0 FISSION PRODUCTS TO PRIMARY SYSTEM (BWR)

4.1 *Fuel cladding defects.*

Release from these events shall be included and evaluated under routine releases in accordance with proposed Appendix I.

4.2 *Off-design transients that induce fuel failures above those expected* (such as flow blockage and flux maldistributions).

(a) 0.02% of the core inventory of noble gases and 0.02% of the core inventory of halogens shall be assumed to be released into the reactor coolant.

(b) 1% of the halogens in the reactor coolant shall be assumed to be released into the steamline.

(c) The mechanical vacuum pump shall be assumed to be automatically isolated by a high radiation signal on the steamline.

(d) Radioactivity shall be assumed to carry over to the condenser where 10% of the halogens shall be assumed to be available for leakage from the condenser to the environment at 0.5%/day for the course of the accident (24 hours).

(e) Meteorology assumptions–χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3 dated November 2, 1970.

[1] 36 FR 11113, June 8, 1971.

[2] Copies of such Guide(s) dated November 2, 1970, are available at the Commission's Public Document Room, 1717 H Street N.W., Washington, D.C., and on request to the Director, Division of Reactor Standards, U.S. Atomic Energy Commission, Washington, D.C. 20545. (These two guides have been revised and reissued as Revision 2, Regulatory Guide 1.3, and Revision 2, Regulatory Guide 1.4, both dated June 1974. Copies of these guides may be obtained by request from the U.S. Atomic Energy Commission, Washington, D.C., 20545, Attention: Director of Regulatory Standards.)

(f) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

ACCIDENT–5.0 FISSION PRODUCTS TO PRIMARY AND SECONDARY SYSTEMS (PRESSURIZED WATER REACTOR)

5.1 *Fuel cladding defects and steam generator leak.* Release from these events shall be included and evaluated under routine releases in accordance with proposed Appendix I.

5.2 *Off-design transients that induce fuel failure above those expected and steam generator leak* (such as flow blockage and flux maldistributions).

(a) 0.02% of the core inventory of noble gases and 0.02% of the core inventory of halogens shall be assumed to be released into the reactor coolant.

(b) Average inventory in the primary system prior to the transient shall be based on operation with 0.5% failed fuel.

(c) Secondary system equilibrium radioactivity prior to the transient shall be based on a 20 gal/day steam generator leak and a 10 gpm blowdown rate.

(d) All noble gases and 0.1% of the halogens in the steam reaching the condenser shall be assumed to be released by the condenser air ejector.

(e) Meteorology assumptions: χ/Q values should be 1/10 of those given in AEC Safety Guide No. 4.

(f) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

5.3 *Steam generator tube rupture.*

(a) 15% of the average inventory of noble gases and halogens in the primary coolant shall be assumed to be released into the secondary coolant.

The average primary coolant activity shall be based on 0.5% failed fuel.

(b) Equilibrium radioactivity prior to rupture shall be based on a 20 gallon per day steam generator leak and a 10 gpm blowdown rate.

(c) All noble gases and 0.1% of the halogens in the steam reaching the condenser shall be assumed to be released by the condenser air ejector.

(d) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 4.

(e) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

ACCIDENT–6.0 REFUELING ACCIDENTS

6.1 *Fuel bundle drop.*

(a) The gap activity (noble gases and halogens) in one row of fuel pins shall be assumed to be released into the water. (Gap activity is 1% of total activity in a pin.)

(b) One week decay time before the accident occurs shall be assumed.

(c) Iodine decontamination factor in water shall be 500.

(d) Charcoal filter efficiency for iodines shall be 99%.

(e) A realistic fraction of the containment volume shall be assumed to leak to the atmosphere prior to isolating the containment.

(f) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3 or 4.

(g) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

6.2 *Heavy object drop onto fuel in core.*

(a) The gap activity (noble gases and halogens) in one average fuel assembly shall be assumed to be released into the water. (Gap activity shall be 1% of total activity in a pin.)

(b) 100 hours of decay time before object is dropped shall be assumed.

(c) Iodine decontamination factor in water shall be 500.

(d) Charcoal filter efficiency for iodines shall be 99%.

(e) A realistic fraction of the containment volume shall be assumed to leak to the atmosphere prior to isolating the containment.

(f) Meteorological assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3 or 4.

(g) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

ACCIDENT–7.0 SPENT FUEL HANDLING ACCIDENT

7.1 *Fuel assembly drop in fuel storage pool.*

(a) The gap activity (noble gases and halogens) in one row of fuel pins shall be assumed to be released into the water. (Gap activity shall be 1% of total activity in a pin.)

(b) One week decay time before accident occurs shall be assumed.

(c) Iodine decontamination factor in water shall be 500.

(d) Charcoal filter efficiency for iodines shall be 99%.

(e) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3 or 4.

(f) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

7.2 *Heavy object drop onto fuel rack.*

(a) The gap activity (noble gases and halogens) in one average fuel assembly shall be assumed to be released into the water. (Gap activity is 1% of total activity in a pin.)

(b) 30 days decay time before the accident occurs shall be assumed.

(c) Iodine decontamination factor in water shall be 500.

(d) Charcoal filter efficiency for iodines shall be 99%.

(e) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3 or 4.

(f) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

7.3 *Fuel cask drop.*

(a) Noble gas gap activity from one fully loaded fuel cask (120-day cooling) shall be assumed to be released. (Gap activity shall be 1% of total activity in the pins.)

(b) Meteorology assumptions–χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3 or 4.

(c) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

ACCIDENT–8.0 ACCIDENT INITIATION EVENTS CONSIDERED IN DESIGN BASIS EVALUATION IN THE SAFETY ANALYSIS REPORT

8.1 *Loss-of-coolant accidents*

Small Pipe Break (6 in. or less)

(a) Source term: the average radioactivity inventory in the primary coolant shall be assumed. (This inventory shall be based on operation with 0.5% failed fuel).

(b) Filter efficiencies shall be 95% for internal filters and 99% for external filters.

(c) 50% building mixing for boiling water reactors shall be assumed.

(d) For the effects of Plateout, Sprays, Decontamination Factor in Pool, and Core Sprays, the following reduction factors shall be assumed:

For pressurized water reactors–0.05 with chemical additives in sprays, 0.2 for no chemical additives.

For boiling water reactors–0.2.

(e) A realistic building leak rate as a function of time shall be assumed.

(f) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3 or 4.

(g) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

Large Pipe Break

(a) Source term: The average radioactivity inventory in the primary coolant shall be assumed. (This inventory shall be based on operation with 0.5% failed fuel), plus release into the coolant of:

For pressurized water reactors–2% of the core inventory of halogens and noble gases.

For boiling water reactors–0.2% of the core inventory of halogens and noble gases.

(b) Filter efficiencies shall be 95% for internal filters and 99% for external filters.

(c) 50% building mixing for boiling water reactors shall be assumed.

(d) For the effects of Plateout, Containment Sprays, Core Sprays (values based on 0.5% of halogens in organic form), the following reduction factors shall be assumed:

For pressurized water reactors –0.05 with chemical additives in sprays, 0.2 for no chemical additives.

For boiling water reactors–0.2.

(e) A realistic building leak rate as a function of time and including design leakage of steamline valves in BWRs shall be assumed.

(f) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3 or 4.

(g) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

8.1(a) *Break in instrument line from primary system that penetrates the containment* (lines not provided with isolation capability inside containment).

(a) The primary coolant inventory of noble gases and halogens shall be based on operation with 0.5% failed fuel.

(b) Release rate through failed line shall be assumed constant for the four-hour duration of the accident.

(c) Charcoal filter efficiency shall be 99%.

(d) Reduction factor from combined plateout and building mixing shall be 0.1.

(e) Meteorology assumptions–χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3.

(f) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

8.2(a) *Rod ejection accident* (pressurized water reactor)

(a) 0.2% of the core inventory of noble gases and halogens shall be assumed to be released into the primary coolant plus the average inventory in the primary coolant based on operation with 0.5% failed fuel.

(b) Loss-of-coolant accident occurs with break size equivalent to diameter of rod housing (see assumptions for Accident 8.1).

8.2(b) *Rod drop accident (boiling water reactor) Radioactive material released*

(a) 0.025% of the core inventory of noble gas and 0.025% of the core inventory of halogens shall be assumed to be released into the coolant.

(b) 1% of the halogens in the reactor coolant shall be assumed to be released into the condenser.

(c) The mechanical vacuum pump shall be assumed to be automatically isolated by high radiation signal on the steamline.

(d) Radioactivity shall be assumed to carry over to the condenser where 10% of the halogens shall be assumed to be available for leakage from the condenser to the environment at 0.5%/day for the course of the accident (24 hours).

(e) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3.

(f) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

8.3(a) *Steamline breaks (pressurized water reactors–outside containment)*
Break size equal to area of safety valve throat.

Small break

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel. The primary system contribution during the course of the accident shall be based on a 20 gal/day tube leak.

(b) During the course of the accident, a halogen reduction factor of 0.1 shall be applied to the primary coolant source when the steam generator tubes are covered; a factor of 0.5 shall be used when the tubes are uncovered.

(c) Secondary coolant system radioactivity prior to the accident shall be based on:
 (a) 20 gallons per day primary-to-secondary leak.
 (b) Blowdown of 10 gpm.

(d) Volume of one steam generator shall be released to the atmosphere with an iodine partition factor of 10.

(e) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 4.

(f) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

Large break

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel. The primary system contribution during the course of the accident shall be based on a 20 gal/day tube leak.

(b) A halogen reduction factor of 0.5 shall be applied to the primary coolant source during the course of the accident.

(c) Secondary coolant system radioactivity prior to the accident shall be based on:
 (a) 20 gallons per day primary-to-secondary leak.
 (b) Blowdown to 10 gpm.

(d) Volume of one steam generator shall be assumed to be released to the atmosphere with an iodine partition factor of 10.

(e) Meteorology assumptions–χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 4.

(f) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

8.3(b) *Steamline breaks (boiling water reactor)*

Small pipe break (of 1/4 ft^2)

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel.

(b) The main steamline shall be assumed to fail, releasing coolant until 5 seconds after isolation signal is received.

(c) Halogens in the fluid released to the atmosphere shall be at 1/10 the primary system liquid concentration.

(d) Meteorology assumptions–χ/Q values shall be 1/10 of those in AEC Safety Guide No. 3.

(e) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

Large break

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel.

(b) Main steamline shall be assumed to fail, releasing that amount of coolant corresponding to a 5 seconds isolation time.

(c) 50% of the halogens in the fluid exiting the break shall be assumed to be released to the atmosphere.

(d) Meteorology assumptions–χ/Q values shall be 1/10 of those in AEC Safety Guide No. 3.

(e) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

(a) 0.025% of the core inventory of noble gas and 0.025% of the core inventory of halogens shall be assumed to be released into the coolant.

(b) 1% of the halogens in the reactor coolant shall be assumed to be released into the condenser.

(c) The mechanical vacuum pump shall be assumed to be automatically isolated by high radiation signal on the steamline.

(d) Radioactivity shall be assumed to carry over to the condenser where 10% of the halogens shall be assumed to be available for leakage from the condenser to the environment at 0.5%/day for the course of the accident (24 hours).

(e) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3.

(f) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

8.3(a) *Steamline breaks (pressurized water reactors–outside containment)*
Break size equal to area of safety valve throat.

Small break

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel. The primary system contribution during the course of the accident shall be based on a 20 gal/day tube leak.
(b) During the course of the accident, a halogen reduction factor of 0.1 shall be applied to the primary coolant source when the steam generator tubes are covered; a factor of 0.5 shall be used when the tubes are uncovered.
(c) Secondary coolant system radioactivity prior to the accident shall be based on:
  (a) 20 gallons per day primary-to-secondary leak.
  (b) Blowdown of 10 gpm.
(d) Volume of one steam generator shall be released to the atmosphere with an iodine partition factor of 10.
(e) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 4.
(f) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

Large break

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel. The primary system contribution during the course of the accident shall be based on a 20 gal/day tube leak.
(b) A halogen reduction factor of 0.5 shall be applied to the primary coolant source during the course of the accident.
(c) Secondary coolant system radioactivity prior to the accident shall be based on:
  (a) 20 gallons per day primary-to-secondary leak.
  (b) Blowdown to 10 gpm.
(d) Volume of one steam generator shall be assumed to be released to the atmosphere with an iodine partition factor of 10.
(e) Meteorology assumptions–χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 4.
(f) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

8.3(b) *Steamline breaks (boiling water reactor)*

Small pipe break (of 1/4 ft^2)

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel.
(b) The main steamline shall be assumed to fail, releasing coolant until 5 seconds after isolation signal is received.
(c) Halogens in the fluid released to the atmosphere shall be at 1/10 the primary system liquid concentration.
(d) Meteorology assumptions–χ/Q values shall be 1/10 of those in AEC Safety Guide No. 3.
(e) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

Large break

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel.
(b) Main steamline shall be assumed to fail, releasing that amount of coolant corresponding to a 5 seconds isolation time.
(c) 50% of the halogens in the fluid exiting the break shall be assumed to be released to the atmosphere.
(d) Meteorology assumptions–χ/Q values shall be 1/10 of those in AEC Safety Guide No. 3.
(e) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

(a) 0.025% of the core inventory of noble gas and 0.025% of the core inventory of halogens shall be assumed to be released into the coolant.

(b) 1% of the halogens in the reactor coolant shall be assumed to be released into the condenser.

(c) The mechanical vacuum pump shall be assumed to be automatically isolated by high radiation signal on the steamline.

(d) Radioactivity shall be assumed to carry over to the condenser where 10% of the halogens shall be assumed to be available for leakage from the condenser to the environment at 0.5%/day for the course of the accident (24 hours).

(e) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 3.

(f) Consequences should be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

8.3(a) *Steamline breaks (pressurized water reactors–outside containment)*
Break size equal to area of safety valve throat.

Small break

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel. The primary system contribution during the course of the accident shall be based on a 20 gal/day tube leak.
(b) During the course of the accident, a halogen reduction factor of 0.1 shall be applied to the primary coolant source when the steam generator tubes are covered; a factor of 0.5 shall be used when the tubes are uncovered.
(c) Secondary coolant system radioactivity prior to the accident shall be based on:
  (a) 20 gallons per day primary-to-secondary leak.
  (b) Blowdown of 10 gpm.
(d) Volume of one steam generator shall be released to the atmosphere with an iodine partition factor of 10.
(e) Meteorology assumptions: χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 4.
(f) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

Large break

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel. The primary system contribution during the course of the accident shall be based on a 20 gal/day tube leak.
(b) A halogen reduction factor of 0.5 shall be applied to the primary coolant source during the course of the accident.
(c) Secondary coolant system radioactivity prior to the accident shall be based on:
  (a) 20 gallons per day primary-to-secondary leak.
  (b) Blowdown to 10 gpm.
(d) Volume of one steam generator shall be assumed to be released to the atmosphere with an iodine partition factor of 10.
(e) Meteorology assumptions–χ/Q values shall be 1/10 of those given in AEC Safety Guide No. 4.
(f) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

8.3(b) *Steamline breaks (boiling water reactor)*

Small pipe break (of 1/4 ft^2)

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel.
(b) The main steamline shall be assumed to fail, releasing coolant until 5 seconds after isolation signal is received.
(c) Halogens in the fluid released to the atmosphere shall be at 1/10 the primary system liquid concentration.
(d) Meteorology assumptions–χ/Q values shall be 1/10 of those in AEC Safety Guide No. 3.
(e) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.

Large break

(a) Primary coolant activity shall be based on operation with 0.5% failed fuel.
(b) Main steamline shall be assumed to fail, releasing that amount of coolant corresponding to a 5 seconds isolation time.
(c) 50% of the halogens in the fluid exiting the break shall be assumed to be released to the atmosphere.
(d) Meteorology assumptions–χ/Q values shall be 1/10 of those in AEC Safety Guide No. 3.
(e) Consequences shall be calculated by weighting the effects in different directions by the frequency the wind blows in each direction.
