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PREPARATION OF ENVIRONMENTAL REPORTS FOR NUCLEAR POWER STATIONS

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OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 4.2

PREPARATION OF ENVIRONMENTAL REPORTS FOR NUCLEAR POWER STATIONS

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A. INTRODUCTION

1. National Environmental Goals

The national environmental goals are expressed by the National Environmental Policy Act (NEPA) of 1969 (Public Law 91-190, 83 Stat. 852), 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 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."

Prior to the issuance of a construction permit or an operating license for a nuclear power station, the Nuclear Regulatory Commission (NRC) is required to assess the potential environmental effects of that facility to ensure that issuance of the permit or license will be consistent with the national environmental goals presented above. In order to obtain information essential to this assessment, the NRC requires each applicant for a permit or a license to submit a report on the potential environmental impacts of the proposed station and associated facilities. The Commission's implementation of NEPA is discussed in Section 3 of this Introduction.

2. Federal Water Pollution Control Act

The responsibilities of the NRC under NEPA are affected by the Federal Water Pollution Control Act (FWPCA) Amendments of 1972 (Public Law 92-500, 86 Stat. 816). The FWPCA gives the U.S. Environmental Protection Agency (EPA) regulatory authority over the discharge of pollutants to waters in the United States from nuclear power stations requiring an NRC license or permit subject to the requirements of 10 CFR Part 51. Section 511 of the FWPCA provides that nothing under NEPA shall be deemed to authorize any Federal agency to review any effluent limitation or other requirements established pursuant to the FWPCA, or to impose, as a condition of any license or permit, any effluent limitation other than any such limitation established pursuant to the FWPCA.

Pursuant to the authority of the FWPCA, EPA requires applicants for discharge permits to submit information required by EPA in order to establish effluent limitations in permits. Pursuant to the authority of NEPA, the NRC may require applicants for licenses or permits to submit information required by NRC in order to evaluate and consider the environmental impacts of any actions it may take. Consequently, the informational needs imposed by the two agencies may be similar in the area of impacts on water quality and biota. In addition, the FWPCA requires that EPA comply with NEPA regarding the issuance of discharge permits for new sources, as defined in the FWPCA, but not for other point sources. The responsibilities of the NRC and EPA under NEPA as affected by the FWPCA are the subject of a memorandum of understanding discussed in Section 3.c.(1) of this Introduction.

In cases where the cooling system proposed in an application does not comply with the thermal effluent limitations under Sections 301 and 306 of Public Law 92-500 (FWPCA), a request for alternative thermal effluent limitations under Section 316(a) may be initiated according to the provisions of 40 CFR Part 122. If the request for alternative thermal effluent limitations under Section 316(a) is denied, the applicant will be required to submit a supplement to the environmental report presenting a description and environmental analysis of the alternative cooling system.

3. NRC Implementing Actions Concerning the Environment

a. Licensing and Regulatory Policy and Procedures for Environmental Protection (10 CFR Part 51)

The Commission's implementation of NEPA[1] is contained in 10 CFR Part 51, "Licensing and Regulatory Policy and Procedures for Environmental Protection."

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

Other relevant information is contained in a proposed Annex, "Discussion of Accidents in Applicants' Environmental Reports: Assumptions," to Appendix D, 10 CFR Part 50 (36 FR 22851).

b. Radiological Impact Assessment (Appendix I to 10 CFR Part 50)

The Nuclear Regulatory Commission published Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low As Is Reasonably Achievable'[2] for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50 in the *Federal Register* (40 FR 19437) as an effective rule on May 5, 1975. This revision of Regulatory Guide 4.2 includes changes in NRC's information requirements made necessary by Appendix I to 10 CFR Part 50.

On September 4, 1975, the NRC published amendments to Appendix I to 10 CFR Part 50 in the *Federal Register* (40 FR 40816). These amendments provide persons who have filed applications for construction permits for light-water-cooled nuclear power reactors that were docketed on or after January 2, 1971, and prior to June 4, 1976, the option of dispensing with the cost-benefit analysis required by Paragraph II.D of Appendix I if the proposed or installed radwaste systems and equipment satisfy the Guides on Design Objectives for Light-Water-Cooled Nuclear Power Reactors proposed in the Concluding Statement of Position of the AEC Regulatory staff in Docket No. RM-50-2 dated February 20, 1974 (reproduced in the Annex to Appendix I to 10 CFR Part 50).

The NRC staff intends to employ realistic analytical models for assessing the potential release of radioactive materials to the environment and for estimating their pathways and impacts over the operating life of the proposed nuclear facility. The models used in determining potential radioactive releases should consider all potential sources and pathways within the proposed station.

The NRC has published a series of regulatory guides[3] that provide guidance in evaluating the potential radiation dose to individuals and populations within 50 miles (80 kilometers) of the station in order to demonstrate compliance with Appendix I to 10 CFR Part 50. These same analytical models can be used to evaluate the radiological impact of the radioactive effluents released during normal operation on the environment within 50 miles of the station.

The following principles stated by the Commission in its opinion on the Appendix I rulemaking proceedings,[4] although specifically related to the provisions of Appendix I, provide useful guidance for evaluating environmental impacts under NEPA.

(1) An applicant should be free to use as realistic a model for characterizing natural phenomena, including plant performance, as he considers useful. An applicant may take into account situations not adequately characterized by such standardized models as may be available with respect to specific features of plant design, proposed modes of plant operation, or local natural environmental features which are not likely to change significantly during the term of plant operation.

(2) Where selection of data is strictly a matter of interpreting experimental evidence, both the applicant and the Regulatory staff should use prudent scientific expertise to select those values which would be expected to yield estimates nearest the real case.

(3) If approximations implicit in a model can produce a deviation from the true result, the direction of which is either uncertain or would tend to underestimate dosage, or if available experimental information leaves a substantial range of uncertainty as to the best estimate of some parameter values, or both, data should be chosen so as to make it unlikely, with all such deviations and uncertainties taken into account together, that the true dose would be underestimated substantially.

(4) The models used in describing effluent releases should take into account all real sources and pathways within the plant; and the estimated releases should be characteristic of the expected average releases over a long period of time, with account taken of normal operation and anticipated operational occurrences over the lifetime of the plant.

(5) The model of the exposed individual and the assumed characteristics of the environs with respect to known occupancy and to land and water use should be

[2]Amended 40 FR 58847, December 19, 1975.

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

[4]From the "Opinion of the Commission," Docket No. RM-50-2. Single copies of this volume may be purchased at a cost of $4.00 from the USERDA Technical Information Center, P.O. Box 62, Oak Ridge, Tennessee 37830. Copies of the complete opinion are also available for inspection and copying in the Commission's Public Document Room, 1717 H Street, NW., Washington, D.C. 20555.

determined in each case in accordance with the intent indicated below for each particular category of effluent for which design-objective guidelines are given.

(a) For design objectives affected by assumptions as to consumption of water or food (other than milk) produced in the environs, one should consider the model individual to be that hypothetical individual who would be maximally exposed with account taken only of such potential occupancies and usages as could actually be realized during the term of plant operation.

(b) For design objectives affected by exposure as a direct result of human occupancy (immersion exposure), the model individual should be the hypothetical individual maximally exposed with account taken only of such potential occupancies, including the fraction of time an individual would be exposed, as could actually be realized during the term of plant operation.

(c) For design objectives relative to thyroid dose as affected by consumption of milk, the iodine pathway through the environs of a plant and the characteristics of the model receptor should be essentially as they actually exist at the time of licensing.

c. Interagency Memoranda of Understanding

The Nuclear Regulatory Commission and other agencies of the Federal government sometimes have overlapping responsibilities regarding the issuance of licenses or permits. For the purposes of coordinating and implementing certain requirements to ensure effective, efficient, and thorough regulation of nuclear power stations and to avoid conflicting and unnecessary duplication of effort and standards related to the overall public health and safety and environmental protection, the NRC and other Federal agencies have entered into several memoranda of understanding.

(1) Memoranda of Understanding Between the NRC and the Environmental Protection Agency

For the purpose of implementing NEPA and the FWPCA in a manner consistent with both acts and the public interest, the Atomic Energy Commission[5] (AEC published in the *Federal Register* (38 FR 2679) on January 29, 1973, an Interim Statement of Policy concerning the effects of Section 511 of the FWPCA upon the AEC's statutory responsibility and authority under NEPA in licensing actions covered by Appendix D to 10 CFR Part 50 (now superseded by 10 CFR Part 51). On the same date, the AEC published in the *Federal Register* (38 FR 2713) a first "Memorandum of Understanding Regarding Implementation of Certain Complementary Responsibilities" between AEC and EPA under the FWPCA.

To further clarify the respective roles of NRC and EPA in the decision-making process concerning nuclear power stations and other facilities requiring an NRC license or permit, a "Second Memorandum of Understanding and Policy Statement Regarding Implementation of Certain NRC and EPA Responsibilities" was published in the *Federal Register* (40 FR 60115) on December 31, 1975. This Second Memorandum of Understanding supersedes the January 29, 1973 Memorandum; NRC has adopted the revised Policy Statement set forth in Appendix A to this Second Memorandum. The revised Policy Statement will serve as the legal basis for NRC decision-making concerning licensing matters covered by NEPA and Section 511 of the FWPCA. Appropriate changes will be made in future revisions of this guide as various implementing actions are developed to meet the provisions of the Second Memorandum of Understanding.

(2) Memorandum of Understanding Between the NRC and the Corps of Engineers, United States Army

Both the Corps of Engineers, United States Army, and the Nuclear Regulatory Commission have responsibilities for assuring that nuclear power stations on coastal and inland navigable waters and at offshore sites are built and operated safely and with minimum impact on the environment. For the purpose of coordinating and implementing consistent and comprehensive requirements to assure effective, efficient, and thorough regulation of nuclear power stations and to avoid conflicting and unnecessary duplication of effort and of standards related to overall public health and safety and environmental protection, the Corps of Engineers, United States Army, and the NRC have entered into a Memorandum of Understanding (40 FR 37110; August 25, 1975).

Under this agreement, the NRC will exercise the primary responsibility in conducting environmental reviews and in preparing environmental statements for nuclear power stations covered by this Memorandum of Understanding.

The Corps of Engineers will participate with the NRC in the preparation of the environmental impact statements to include the drafting of material for the sections that consider and evaluate the following topics, as applicable, and the analysis leading thereto:

(a) Coastal erosion and other shoreline modifications, shoaling, and scouring;

[5]The Atomic Energy Commission was abolished by the Energy Reorganization Act of 1974, which also created the Nuclear Regulatory Commission and gave it the licensing and related regulatory functions of the AEC.

(b) Siltation and sedimentation processes;

(c) Dredging activities and disposal of dredged materials; and

(d) Location of structures in or affecting navigable waters.

The Commission is developing specific guidance concerning the information to be requested from applicants in order to meet the provisions of this Memorandum of Understanding. As various implementing actions are taken, appropriate changes will be made in this guide.

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 NRC places a copy of each applicant's environmental report in the Commission'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. In addition, a public announcement is made, and a summary notice of the availability of the report is published in the *Federal Register*.

The applicant's environmental report and any comments received from interested persons are considered by the NRC staff in preparing a Draft Environmental Impact Statement (DES) concerning the proposed licensing action. The NRC staff's draft statement, the applicant's environmental report, and any comments received on the statement or report are provided to the Council on Environmental Quality. Copies of the draft statement and the applicant's environmental report will be provided to (a) those Federal agencies that have special expertise or jurisdiction by law with respect to any environmental impacts involved and which are authorized to develop and enforce relevant environmental standards; (b) the Environmental Protection Agency; and (c) the appropriate State and local agencies authorized to develop and enforce relevant environmental standards and the appropriate State, regional, and metropolitan clearinghouses. A reasonable effort will be made to distribute draft environmental statements prepared for licensing actions to all States that may be affected and to appropriate national and local environmental organizations. The draft statement is made available to the general public in the same manner as is the applicant's environmental report. Comments on the applicant's environmental report and the draft statement are requested within a specified time interval. 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 NRC 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 (FES). 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 NRC's Final Environmental Impact Statement. The FES takes into account information from many sources, including the applicant's environmental report and its supplements and the comments of the various governmental agencies, the applicant, and private organizations and individuals.

5. Cost-Benefit Analysis

The cost-benefit analysis referred to in paragraph 51.20(b) of 10 CFR Part 51 should consist of two parts. In the first part, alternative site-plant combinations (site-plant combinations are defined and discussed in Chapter 9) and station systems should be examined in order to show that the proposed facility is the cost-effective choice, considering economic, social, and other environmental factors and any institutional (governmental, etc.) constraints. 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.

6. Environmental Reports

Sections 51.20 and 51.21 of 10 CFR Part 51 require the applicant to submit two environmental reports (see Appendices A and B). 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's environmental reports are important documents of public record. Therefore, the applicant is urged to give full attention to their completeness.

If the site for a nuclear power station already contains one or more units (i.e., steam-electric plants) in operation, under construction, or for which an application for a construction permit or operating license has been filed, the applicant should consider the environmental effects of the proposed units (and their inservice schedule) in conjunction with the effects of existing or planned units. Furthermore, if the site contains significant sources of environmental impact other than electric power units, the interactions of these sources with the proposed nuclear unit should be taken into account.

Effects between units are considered especially important as efforts to conserve such resources as water focus on the transfer and reuse of materials within plant complexes. In addition, 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 nuclear station.

a. Construction Permit Stage

The applicant should present sufficient information in the environmental report that is submitted with the application for a construction permit to allow 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 should (1) document the critical life stages and biologically significant activities (e.g., spawning, nesting, migration) that increase the vulnerability of the potentially affected biota at the proposed site and (2) characterize the seasonal variations of biota likely to be affected by the station.

An applicant wishing to accelerate the start of construction by early submittal of the environmental report (according to the procedure set forth in paragraph 50.10(e) of 10 CFR Part 50) may submit an initial evaluation of environmental impact based on an analysis of at least 6 months of field data related to the proposed facility and suitable projections of the remaining seasonal periods if the information called for in item (1) above is provided. If this is done, the applicant should also make a commitment to furnish, within 6 months of the time of filing, a final evaluation based on a full year of field data.

b. Operating License Stage

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 station (including those that would degrade and those that 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 station design, availability of new or more detailed information, or changes in surrounding land use, water use, or zoning classifications.)

(2) Discuss the results of studies that were not completed at the time of preconstruction review and that 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 station.

(3) Describe the scope of the monitoring programs that have been and will be undertaken to determine the effects of the operating station on the environment. Include any monitoring programs being developed or carried out in cooperation with Federal and State fish and wildlife services. The result of preoperational monitoring activities should be presented (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 station.

(5) Propose environmental technical specifications. The recommended format for these specifications is presented in Regulatory Guide 4.8, "Environmental Technical Specifications for Nuclear Power Plants." 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.

7. Preparation of Environmental Reports

a. Purpose of This Guide

Section B of this guide identifies the information needed by the staff in its assessment of the potential environmental effects of the proposed nuclear facility and establishes a format acceptable to the staff for its presentation. Use of the format of this guide will help ensure the completeness of the information provided, will assist the NRC staff and others in locating the information, and will aid in shortening the time needed for the review process. Conformance with this format, however, is not required. An environmental report with a different format will be acceptable to the staff if it provides an adequate basis for the findings requisite to the issuance of a license or permit. However, because it may be more difficult to locate needed information, the staff review time for such a report may be longer, and there is a greater likelihood that the staff may regard the report as incomplete.

The staff plans to provide additional information on a data retrieval system (outlined in Appendix C) in a future revision of this guide.

In developing the implementation policy for Regulatory Guide 4.2, Revision 2, both the difficulties that applicants might face unless a suitable transition period was provided and the NRC staff's need for information to complete the review of applications for construction permits and operating licenses have been considered. Therefore, the NRC staff will use Regulatory Guide 4.2, Revision 2, in the evaluation of environmental reports submitted in connection with applications docketed after December 31, 1976.

If an applicant wishes to use this revision in developing the environmental report submitted in connection with an application docketed on or prior to December 31, 1976, the report will be evaluated on the basis of pertinent portions of this revision of the guide.

b. Scope

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

Some of the text of this guide (e.g., Section 7.1) has been written with specific reference to light-water-cooled reactors. For applicants proposing to construct and operate other types of reactors, 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.

c. Presentation of Information

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 that 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.

The applicant should strive for clear, concise presentations of the information provided in the environmental report. Each subject should be treated in sufficient depth and should be documented[6] to permit a reviewer to evaluate the extent of the environmental impact independently. The length of the environmental report will depend on the nature of the station and its environment. Tables, line drawings, and photographs should be used wherever they contribute to the clarity and brevity of the report. The number of significant figures stated in numerical data should reflect the accuracy of the data.

Pertinent published information relating to the site, the station, and its surroundings should be referenced. Where published information is essential for evaluation of specific environmental effects of the station 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. If the applicant considers the reports of work it supported will contribute to the environmental impact analysis, these may be included as appendices.

[6]*Documentation* as used in this guide means presentation of information, 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 its environmental report, the applicant should demonstrate the purpose of, and thus the benefits of, the proposed facility with respect to the power requirements to be satisfied, the system reliability to be achieved, or any other primary objectives of the facility and how these objectives would be affected by variations in the scheduled operation of the proposed station. In this chapter, the term "applicant's system" includes all existing, committed, and planned generating units owned in whole or in part by the applicant and all large (greater than 100 MWe), existing, committed, and planned generating units not owned in whole or in part by the applicant that it plans to rely on for meeting demand and reliability requirements to which it is committed.

1.1 System Demand and Reliability

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 impact of applicable energy conservation and other potential load-affecting programs on its planning effort. Inconsistencies between the data presented and that furnished to the Federal Power Commission (FPC) or the regional reliability council should be explained.

The discussion on the applicant's energy conservation program should mention the steps that have been taken and those being planned to encourage energy conservation in connection with such matters as advertising, sales promotion, consumer education, rate structure, and efficiency of production and utilization of electricity. Evidence of the effects of increasing rates on consumption of electrical energy and forecasts of future impacts on demand from further rate increases should be included in the discussion.

A full and clear description of the applicant's system should be provided, including, for each generating unit or group of units, the extent of ownership by the applicant and the commitments involved. Where an entire power pool, planning area, reliability council, coordinating agreement, etc., is involved, identification should be clear and details should be presented in separate tables.

1.1.1 Load Characteristics

In order to portray the relationship of the proposed generating 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 at least 10 years prior to the filing of the environmental report should be reported. In addition, the future projected annual peak demand should be reported from the year of filing of the environmental report up to and including, as a minimum, the first 24 months 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 applicant should present the expected annual load duration curve for at least 24 months following the start of commercial operation of 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 involved in the forecasting methodology. Specifically, any changes in the demand projections expected on the basis of alternative assumptions made about household formation, migration, personal income, industrial and commercial construction volume and location, or other factors 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 latest forecast peak load should be provided, as well as both actual and latest 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 in an appendix to the environmental report.

The applicant should describe its forecasting methods. Where regression equations or elasticity demand models are used to estimate projections, all statistical measures of correlation should be provided. If the method of correlation forecasting is used, the historic electric loads should be correlated with such variables as population, gross national product, consumer income, Federal Reserve Board Index of Industrial Production, appliance saturation, or other factors. Wherever possible and to the extent that demand projections are based on the accuracy of past demand projections for the applicant's system performed on the same or a comparable basis, these past demand projections should be shown and compared with the past loads. This comparison of the applicant's earlier projections and the actual loads experienced should be listed in a table along with the percent deviation between the previously forecasted loads and past loads.

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 5 years preceding filing of the environmental report through at least 2 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 greater 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 (hydroelectric, 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 employed for the scheduling of outages of individual generating units within the applicant's system.

2. 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.

3. 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.

4. 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 statements should be 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 operation of 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 station 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[1] 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 station property lines. The area of station property in acres should be stated.

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

3. The location and orientation of principal station 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 station 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 that will permit the measurement of distances with reasonable accuracy.

7. True north.

8. Highways, railways, and waterways that 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 is reasonably achievable 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 station effluent release points to the boundary line should be defined clearly.

2.1.2 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.

2.1.2.1 Population Within 10 Miles. On a map of suitable scale that 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 22½-degree sectors with each sector centered on one of the 16 compass points (with reference to true north, e.g., north-northeast, northeast, etc.). A table appropriately keyed to the map should provide the current residential population within each area of the map formed by the concentric circles and radial lines. The same table or separate tables should provide the projected population within each area for (1) the expected first year of station operation and (2) by census decade (e.g., 1990) through the projected station 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. Furnish the age distribution of the projected population (e.g., 0 to 12 years, 12 to 18 years, > 18 years) for the year corresponding to the midpoint of the station operating life. The distribution by age of the U.S. population may be used provided there is no

[1]*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.

knowledge the site has a significantly different distribution. Appendix D provides guidance concerning the use of the U.S. age population distribution.

2.1.2.2 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. Furnish the age distribution of the projected population (e.g., 0 to 12 years, 12 to 18 years, > 18 years) for the year corresponding to the midpoint of the station operating life. The distribution by age of the U.S. population may be used provided there is no knowledge the site has a significantly different distribution. Appendix D provides guidance concerning the use of the U.S. age population distribution.

2.1.2.3 Transient Population. Seasonal and daily variations in population and population distribution within 10 miles of the proposed station resulting from land uses such as recreational or industrial should be generally described and appropriately keyed to the areas and population numbers contained on the maps and tables of Sections 2.1.2.1 and 2.1.2.2. If the station is located in an area where significant population variations due to transient land use are expected, additional tables of population distribution should be provided to indicate peak seasonal and daily populations. The additional tables should cover projected as well as current populations. Wherever possible, applicants should state the expected residence times for the transient population.

2.1.3 Uses of Adjacent Lands and Waters

On detailed topographical maps, show the locations of the station 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 (e.g., railroads, highways, waterways). Indicate the total acreage owned by the applicant and that part occupied or modified by the station and station 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 Section 2.1.2 above:

1. Nearest milk cow (to a distance of 5 miles)
2. Nearest milk goat (to a distance of 5 miles)
3. Nearest residence (to a distance of 5 miles)
4. Nearest site boundary
5. Nearest vegetable garden (greater than 500 ft^2 in area; to a distance of 5 miles)

Indicate which, if any, of the cow and goat locations are dairy operations. Where possible, the applicant should provide specific information on the actual usage of the milk, whether the milk is used raw by infants, children, or adults or whether or not the milk goes to a dairy. Estimate the dairy dilution factor, and provide the basis. Determine the fraction of the milk at the dairy that is used to produce dairy products such as butter, whey, etc.

Indicate (for the 5-mile-radius area) the nature and extent of present and projected land use (e.g., agriculture, livestock raising, dairies, pasturelands, residences, wildlife preserves, sanctuaries, hunting areas, industries, recreation, transportation) and any recent trends such as abnormal changes in population or industrial patterns. If the area near the station 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.

Provide data on annual meat (kg/yr), milk (liters/yr), and truck farming production (kg/yr) and distribution within a 50-mile radius from the proposed reactor. Provide the data by sectors in the same manner as indicated in Sections 2.1.2.1 and 2.1.2.2. Furnish information on type, quantity (kg/yr), and yield (kg/m^2) of crops grown within a 50-mile radius from the proposed reactor. Provide information on grazing season (give dates), feeding regimes for cattle (such as grazing practices, green chop feeding, corn and grass silage feeding, and hay feeding), pasture grass density (kg/m^2), and yield statistics (kg/m^2) for harvested forage crops for beef and dairy cattle feeding within a 50-mile radius of the proposed reactor. Agricultural production, crop yield, grazing, and feeding data may be obtained from sources such as local and State agricultural agencies, agricultural agents, and other reliable sources.

Determine and indicate in tabular format the past, present, and projected commercial fish and shellfish catch (according to the National Marine Fisheries Service (NMFS) standard reporting units) from contiguous waters within 50 miles of the station discharge. Report the catch by total landings and by principal species, indicating the amounts used as human food. Indicate the location of principal fishing areas and ports of landing associated with these contiguous waters, and relate these locations to harvest by species. Note the amounts consumed locally. Determine and tabulate the present and projected recreational fish and shellfish harvest from these waters in the same format, also indicating principal fishing areas and their respective yield by species. As above, indicate the amounts consumed locally. Include any harvest and use of seaweed, other aquatic life, or any vegetation used as human food from these waters.

Indicate the closest location to the point of discharge that is publicly accessible (from land and from water) and influenced by the discharge flow. Provide a qualitative estimate of the fishing success that a fisherman could have at this location. Identify and describe any fish farms or similar aquatic activity within the 50-mile area utilizing water that reasonably may be affected by the power station discharge. Indicate the species and production from each of these facilities and the amounts consumed locally. If hunting occurs within 50 miles of the station, determine the average annual harvest by species, and indicate the amount of game that will be consumed locally. Fish landings, recreational and commercial fin and shellfish harvests, and hunting and game information may be obtained from sources such as Federal, State, and county recreation, conservation, game, and fish agencies. Institutional or other authoritative sources may also be used. Where adequate data are not available, the applicant should determine the information independently.

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.

On a monthly basis, identify the location, nature, and amounts of present and projected surface and ground water use (e.g., water supplies, irrigation, reservoirs, recreation, and transportation) within 50 miles of the station where the water supplies may be contaminated by station effluents and the present and projected population associated with each use point, where appropriate. In addition, all population centers taking water from waterways between the station and the ocean, or such lesser distance as the applicant can technically justify, should be tabulated (distance, uses, amounts, and population). Sources that are river bank wells should be tabulated separately with their associated populations. The effect of present and projected regional consumptive water uses by the station on the supplies or vice versa should be identified. Water and sewage treatment processes should be described where water suppliers may be affected by station effluents.

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

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

2. Distance from Station: Separate intake and discharge locations should be identified as follows:

a. Identify radial distance from station for each water user;

b. Provide distance from station via water route, or by River Mile, etc.;

3. Coordinates: Provide map coordinates, if appropriate;

4. Withdrawal Rate: Provide present and projected withdrawal rate (in cfs or gpm) for each water use;

5. Return Rates: Provide present and projected return rates (in cfs or gpm) if appropriate:

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

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

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

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

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 station 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,[2] (c) the species affects the well-being of some important species within criteria (a) or (b), or (d) the species is critical to the structure and function of the ecological system or is a biological indicator of radionuclides in the environment.

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

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

The discussion of species-environment relationships should include descriptions of area usage (e.g., habitat, breeding, etc.) for important species; it should include life histories of important regional animals and aquatic organisms, their normal seasonal population fluctuations, the density and distribution of their planktonic life stages, 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 station on the regional biota.

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

The information 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 pertinent published material dealing with the ecology of the region. Locate and describe any ecological or biological studies of the site or its environs currently in progress.

[2]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.

2.3 Meteorology[3]

This section should provide a meteorological description of the site and its surrounding area. The description should include the use of at least one annual cycle from the onsite meteorological program for a construction permit application and at least two annual cycles (preferably three or more whole years), including the most recent 1-year period, for an operating license application, plus examination of additional regional meteorological information. Sufficient data should be included to permit independent evaluations and assessments of atmospheric diffusion characteristics and station impacts on the environment. A discussion of climatology, existing levels of air pollution and their effects on station operations, the relationship of the meteorological data gathered on a regional basis to local data, and the impact of the local terrain and large lakes and other bodies of water on meteorological conditions in the area should also be included.

The following data concerning site meteorology, taken from onsite meteorological measurements and nearby representative stations, should be presented:

1. Diurnal and monthly averages and extremes of temperature, dewpoint, and humidity;

2. Monthly and annual wind speed and direction data in joint frequency form at all heights of measurement representative of wind characteristics for points of effluent release to, and transport within, the atmosphere;

3. Monthly and annual joint frequencies of wind direction and speed by atmospheric stability class at heights and intervals relevant to atmospheric transport of effluents;

4. Total precipitation by month, number of hours with precipitation, rainfall rate distributions, and monthly precipitation wind roses;

5. Frequency of occurrence of winds greater than 50 knots by storm type (e.g., orographic or synoptic flow regimes, tornadoes, and hurricanes).

This information should be fully documented and substantiated as to validity of its representation of expected long-term conditions at and near the site.

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

Guidance on acceptable onsite meteorological measurements and data format is presented in Regulatory Guide 1.23 (Safety Guide 23), "Onsite Meteorological Programs."

Sufficient meteorological information should also be provided to adequately characterize atmospheric transport processes (i.e., airflow trajectories, diffusion conditions, deposition characteristics) out to a distance of 50 miles from the nuclear station. The primary source of meteorological information is the onsite meteorological program. Other sources of meteorological information could include available National Weather Service (NWS) stations, meteorological programs that are well maintained and well exposed (e.g., other nuclear facilities, university, private meteorological programs), and additional satellite meteorological facilities established by the applicant to characterize relevant conditions at critical onsite and offsite locations. Adequate characterization of atmospheric transport processes within 50 miles of the station may include examination of meteorological data from stations farther than 50 miles from the station when this information can provide additional clarification of the mesoscale atmospheric transport processes. For an assessment of atmospheric transport to distances of 50 miles from the station, the following additional regional meteorological information (based on at least a 1-year period of record) should be presented for as many relevant stations as practicable:

1. Wind speed and direction data at all heights at which wind characteristic data are applicable or have been measured;

2. Atmospheric stability as defined by vertical temperature gradient or other well-documented parameters that have been substantiated by diffusion data;

3. Monthly mixing height data; and

4. Total precipitation by month, number of hours with precipitation, rainfall rate distributions, and monthly precipitation wind roses.

All meteorological data should be concurrent for each station with the onsite data collection periods, presented by hour, and should be available on magnetic tapes. In addition, a map showing the detailed topographic features (as modified by the station) on a large scale within a 5-mile radius of the station, a smaller scale map showing topography within a 50-mile radius of the station, and a plot of maximum elevation versus distance from the center of the station in each of the sixteen 22½-degree compass point sectors (i.e., centered on true north, northnortheast, northeast, etc.) radiating from the station to a distance of 50 miles should be presented.

For assessment of the impact of station operation on the environment, data summaries (e.g., moisture deficit, visibility, solar radiation) should be presented to support the description given in Section 5.1.4 of the frequency and extent of fogging and icing conditions and other impacts on the atmospheric environment due to station presence and operation.

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 6 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, it may present information applicable to the general site area from the National Weather Service or other authoritative sources. The detailed site-specific data may be scheduled in accordance with Section 6, "Environmental Reports," of the Introduction to this guide.

2.4 Hydrology[4]

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

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

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

The applicant should identify, to the extent possible, the source and nature of the background pollutants (e.g., chemical species and physical characteristics such as

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

color and temperature), the range of concentrations involved, and the time variations in release. Information relating to water quality characteristics should include measurements made on or in close proximity to the site.

Station construction and operation will affect the hydrologic characteristics in the site area. Information should be provided to establish the bases for estimates of the effects. For systems involving water impoundments, the flow rates (in and out), evaporation, drawdown, percolation, evapotranspiration, and net volumes should be provided. In addition, provide elevation-area-capacity curves. Furnish sufficient site-specific data to justify the evaluation of the effects of construction and operation of the station on established ground water tables and usage.

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

In order to develop a systematic evaluation of the interaction of proposed releases with the receiving water, and to permit establishment of distributional isopleths of temperature or chemical and radionuclide concentrations, as discussed in Chapter 5 of this guide, detailed hydrologic descriptions of the site environment to a radius of 50 miles are necessary. (Note that water use is discussed in Section 2.1.3.)

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

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

For the ground water environment, the hydrologic information should include descriptions of the major aquifers in the area, ground water piezometric contour maps of pre- and postconstruction conditions, hydraulic gradients, permeabilities for representative geologic features, total and effective porosities, bulk density estimates, storage coefficients, dispersion and distribution (sorption) coefficients, descriptions of pertinent geologic formations and soil types, including formation depth throughout the site and to the nearest downgradient well or water body (note that geology is discussed in Section 2.5), chemical properties, and time histories of ground water fluctuations. The applicant should provide data concerning any drawdown of ground water caused by withdrawals from neighboring major industrial and municipal wells that may result in the transport of material from the site to these or other wells.

Where features of a proposed station such as foundations, excavations, artificial lakes, and canals create artificial conduits for flow of ground water between and among aquifers, the applicant should furnish sufficient site-specific detail to justify its evaluation of the effects of construction and operation of the station on established ground water tables and usage. (Note that water use at the site is discussed in Section 2.1.3.)

In addition to providing the information described above for the hydrologic environment in the immediate vicinity of the station, information should also be provided for all points that could be affected by station construction and operation within the 50-mile radius where water is withdrawn or where there are significant changes in important parameters. All data for parameters should be adjusted to both present-day conditions and to those that may reasonably be expected to occur over the life of the station. Chemical and biological parameters of the hydrologic environment should be described in a like manner.

The amount of information required for evaluation of radionuclide transport in water should be commensurate with the models used in support of the analysis required in Appendix I to 10 CFR Part 50.

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 station 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, Archeological, Architectural, Scenic, Cultural, and Natural Features

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

The *National Registry of National Landmarks* appears in 37 FR 1496. The *National Register of Historic Places* is published annually in the *Federal Register*; additions are published in the *Federal Register* on the first Tuesday of each month. General guidance on the treatment of historic, archeological, architectural, and cultural features can be obtained from the National Park Service publication, "Preparation of Environmental Statements: Guidelines for Discussion of Cultural (Historic, Archeological, Architectural) Resources," August 1973.[5]

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

The environmental report should also indicate whether or not the site has any archeological significance and how this conclusion was reached. Where necessary, professional quality assessments should be undertaken by archeologists.. If such significance or value is present, the applicant's plans to ensure its preservation or plans filed in a public agency for this purpose should be described. The environmental report should contain evidence of any steps taken to recover historical and archeological data affected by station construction or transmission lines in accordance with the Historic and Archeological Preservation Act of 1974 (PL 93-291).

In addition, the applicant should provide an assessment of the visual effects of the station and transmission lines on nearby valued cultural, scenic, historic, park, and recreation areas. The assessment should include drawings or modified photographs indicating the station 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 rights-of-way from the station 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.

2.7 Noise

Ambient noise levels obtained from the surrounding biotic communities within 5 miles of the proposed station should be reported. Particular attention should be directed toward obtaining acoustic noise levels where high voltage transmission lines are located. Federal and State noise standards should be referenced, where applicable.

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

CHAPTER 3

THE STATION

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

3.1 External Appearance

The building layout and station perimeter should be illustrated and related to the site maps presented in Section 2.1. The station 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 esthetically 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 (e.g.., BWR, PWR, HTGR), 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 station's electrical power consumption, should be given.

The relationship of station 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. The proposed station operating life (years) should be indicated.

3.3 Station Water Use

A quantitative water-use diagram for the station showing anticipated maximum and monthly average flow rates to and from the various station water systems (e.g., heat dissipation system, sanitary system, radwaste and chemical waste systems, process water systems) should be presented. The sources of the water for each input should be described. The anticipated maximum and monthly average consumptive use of water by the station should be shown. The above data that quantify station water use should be tabulated for various station conditions, including maximum power operation, minimum anticipated power operation, and temporary shutdown, with or without cooling towers and cooling ponds (if seasonal usage is planned). To avoid excessive detail on the diagrams, 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 water bodies from which cooling water is withdrawn and to which cooling water is returned should be identified. (Natural temperatures, 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 water use, return, design, size, and location of cooling towers, cooling lakes and ponds, canals with spray modules, 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 and spray systems; blowdown volume, rate of discharge, and physical and chemical characteristics for cooling towers, spray systems, and ponds; temperature changes, rate of changes, and holdup times in cooling ponds or artificial lakes; and rate of evaporation of water (by months) from towers, ponds, lakes, or other related cooling facilities. Also include information on dams or dikes where a cooling reservoir is created to include essential features of the interior flow patterns; 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. The methods used to prevent the initial accumulation of slime and algae and 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.

Include a description of all details supporting the claims that any of the exemptions regarding the discharge of heat in hot side blowdown as permitted by 40 CFR Part 423, Section 423.13(*l*)(2), is warranted with respect to the requirement that "there shall be no discharge of heat from the main condensers."

3.5 Radwaste Systems and Source Term

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

Describe in detail the capabilities of the proposed radwaste treatment systems to maintain releases of radioactive materials in effluents to "as low as is reasonably achievable" levels in conformance with 10 CFR Parts 20 and 50 including the cost-benefit analysis required by Appendix I to 10 CFR Part 50.

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

3.5.1 Source Term

Provide the sources of radioactivity that serve as input to the liquid, gaseous, and solid radioactive waste treatment systems for normal operation and anticipated operational occurrences. Describe the calculational model used to determine the activity of each radionuclide 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. Cite pertinent operating experience where data are available. The activation of water and constituents normally found in the reactor coolant system should also be taken into account. Sources of isotopes (e.g., N-16, Ar-41), together with the concentration of each isotope, should be identified.

Identify sources and appearance rate 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.

Provide piping and instrumentation diagrams (P&IDs) for fuel pool cooling and purification systems and for fuel pool ventilation systems. Provide the volume of the fuel pool and refueling canal, identify sources 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 and cite pertinent operating experience.

For purposes of evaluating the effluents 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. 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. Tabulate the sources of leakage and estimate their contribution to the total quantity. Describe special design features provided to reduce leakage. Provide estimates of the releases of radioactive gases, radioactive particulates, and radioiodines (by radionuclide) from each leakage source, and describe their subsequent transport mechanisms and release paths. Provide the bases for the values used. Cite previous pertinent experience from operating reactors, describing any changes from previous designs that would affect the release of radioactive materials to the environment.

Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," may be referenced, as appropriate, in providing the above information.

Provide responses to the source term questionnaires and to the cost-benefit analysis questionnaire which appear as Appendices E, F, and G 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 occurrences. Provide piping and instrumentation diagrams and flow diagrams for liquid radwaste systems. Reference may be made to the appropriate sections in the PSAR. Show tank capacities, system flow rates, and design capacities of components. Show all interconnections with other systems and all potential bypass paths. Identify the normal mode of operation. Provide estimated quantities and flow rates from all sources, expected decontamination factors, and holdup times. Estimated quantities should be given in terms of gallons, total curie content, and activity concentration in 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 (Ci/yr per reactor).

An evaluation should be provided showing conformance with the design objectives specified in Appendix I to 10 CFR Part 50, Section II, Paragraphs A and D. With regard to Paragraph D, tabulate the components and the parameters considered in the cost-benefit analyses, along with dollar/man-rem reduction. Analyses should be based on a 30-year station operating life. Describe the cost-benefit analysis model in sufficient detail that the tabulated values can be verified. Provide the bases for all assumptions and parameters used in the analyses. Provide design specifications for all equipment involved in the cost-benefit analyses. Regulatory Guide 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors," may be referenced, as appropriate, in providing the above information.

3.5.3 Gaseous Radwaste Systems

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

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

Provide an evaluation showing conformance with the design objectives specified in Appendix I to 10 CFR Part 50, Section II, Paragraphs B, C, and D. With regard to Paragraph D, tabulate the components and the parameters considered in the cost-benefit analyses along with the dollar/man-rem reduction. Analyses should be based on a 30-year station operating life. Describe the cost-benefit analysis model in detail sufficient to verify the tabulated values. Provide the bases for all assumptions and the parameters used in the analyses. Give the design specifications for all equipment involved in the cost-benefit analyses. Regulatory Guide 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors," may be referenced, as appropriate, in providing the above information.

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

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

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

3.5.5 Process and Effluent Monitoring

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

3.6 Chemical and Biocide Wastes

The applicant should provide a complete list of all chemicals (including scaling and corrosion inhibitors, chemical and biological antifouling agents, and cleaning compounds) to be used at the proposed station. Chemical names should be given in addition to generic or trade names wherever possible. The list should describe in tabular form the use of each chemical agent, the frequency of use, and the average and maximum quantities (pounds) used annually.

The applicant should describe average and expected maximum design discharge concentrations of chemicals, including corrosion products, that may enter the environment as a result of station operation.

Sources of chemicals discharged by the station should be identified by the waste categories specified in 40 CFR Part 423, "Effluent Guidelines and Standards for the Steam Electric Power Generating Point Source Category," issued by the Environmental Protection Agency, and should include, where applicable, circulating and service water systems; blowdown from recirculating cooling water systems; low-volume waste discharge systems such as demineralizer regenerant waste, water treatment sludge supernatant, filter backwash, steam generator blowdown; area rainfall runoff from construction activities and materials storage piles; waste streams or discharges from roof, yard, and other drains; laundry waste streams which may also contain radionuclides; and other waste streams that may enter the local environment as a result of station operation.

Maximum and average concentrations (in mg/liter) of chemicals and solids in any brines or cooling system effluents should be given. The expected average and maximum design discharge concentrations of each pollutant for each permitted station discharge should be listed in a table along with the chemical concentrations in each of the above-mentioned waste source categories, where applicable, and the chemical concentration of the intake water supply. Each pollutant in the station's cooling system effluent should be compared with applicable State and Federal (40 CFR Part 423) effluent limitations guidelines and reported in the table. All flow rates, frequencies of discharge, and regenerant times for the waste sources should also be included in the table. Quantities of chemicals discharged with treated or partially treated waste streams not covered by 40 CFR Part 423 should be specifically listed.

Where discharges of free available chlorine or total residual chlorine are not in compliance with 40 CFR Part 423 guidelines, details should be given which support any conclusion that the proposed unit(s) cannot operate at or below this level of chlorination and thus a variance from the effluent limitations of 40 CFR Part 423 is warranted (as is currently allowed by 40 CFR Part 423).

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 State and EPA effluent limitation guidelines and new source performance standards. 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 station 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 limitation guidelines and standards of performance under FWPCA should be described.

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

3.8 Reporting of Radioactive Material Movement

The detailed requirements for the analysis of environmental impacts involving the transportation of radioactive materials to and from nuclear power reactors is contained in 10 CFR Part 51.

If the transportation of fuel and waste to and from nuclear power reactors is within the scope of paragraph (g) of §51.20, the environmental report need only contain a statement that such environmental impacts are as set forth in Summary Table S-4 of 10 CFR Part 51 (see Appendix A). No further discussion of such environmental effects will be required.

If the transportation of fuel and waste to and from nuclear power reactors is not within the scope of paragraph (g) of §51.20, a full description and detailed analysis of the environmental impacts of transportation of radioactive materials under normal conditions of transport will be required. An analysis of the environmental impacts of transportation of radioactive materials following the approach set forth in WASH-1238 is acceptable.[1]

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 section, 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,*[2] and the National Electrical 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 esthetic 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 transmission structures, and provide profile drawings of the conductors and transmission structures to be located in highly visible areas. Indicate the dimensions, materials, color, and finish of the transmission structures, substations, and other related facilities.

The applicant should supply contour maps or aerial photographs, or both, 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 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.

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[1] 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, December 1972, and Supplement I to WASH-1238, NUREG-75/038, April 1975. Copies of WASH-1238 and NUREG-75/038 may be obtained from the National Technical Information Service, Springfield, Virginia 22161.

[2] Copies may be obtained from Fred Weidner and Son, Printers, 421 Hudson St., New York, NY 10014.

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.[3] Appropriate State and Federal standards should be referenced, as applicable.

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

CHAPTER 4

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

This chapter of the applicant's environmental report should discuss the expected effects of site preparation and station 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 station 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 esthetically 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 esthetically treasured natural areas as well as expenditure of directly utilized resources.)

4.1 Site Preparation and Station Construction

The applicant should organize the discussion in terms of the effects of site preparation and station 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 above.

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? How will explosives 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 applicant should show in tabular form the land area requirements (in acres) affected by the station and station-related facilities. Where applicable, acreage should be specified for the site, station, cooling towers (main condenser and service water), switching stations, safe-shutdown and emergency cooling ponds, transmission line corridors (both onsite and offsite), railroad spurs (both onsite and offsite) to be constructed, access roads, makeup and blowdown pipes, intake structures, parking lots, permanent buildings, and any other facility or pond occupying more than 2 acres.

An annual schedule of the estimated work force to be involved in site preparation and station construction should be presented. Describe any expected changes in accessibility of historical, cultural,[1] and archeological sites and natural landmarks in the region.

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

The discussion of water use should describe the impact of site preparation and construction activities on regional water (e.g., lakes, streams, ground water). The overall plan for protection of water bodies (e.g., recreation, reservoir) that may be affected by station 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

[1] 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 its review and independently notify the National Oceanic and Atmospheric Administration, National Geodetic Survey (NGS) of any impending damage to markers so that efforts can be made to relocate them prior to destruction.

facilities involving bulkheads, piers, jetties, basins, or other structures allowing ingress to or egress from the station 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, and operations affecting water level (flooding), construction, and dewatering effects on nearby ground water users. The applicant should describe the effects of these activities on navigation, fish and wildlife resources, water quality, water supply, esthetics, etc., as applicable.

Where it is proposed to create a cooling lake or pond, describe the effects on the local ecology, including the loss of flora and local migration of fauna from the area the lake or pond 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 rights-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 rights-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 rights-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 (e.g., loss of land, water, nonrecyclable building materials, destruction of biota) that are expected if site preparation and construction of station and transmission facilities proceed. Commitments of material resources involved in the construction of nuclear reactors are discussed in Regulatory Guide 4.10, "Irreversible and Irretrievable Commitments of Material Resources." Such losses should be evaluated in terms of their relative and long-term net and absolute impacts. (See Section 5.7 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 (e.g., direct radiation from the gaseous radioactive plume). 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[2]

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

The applicant should describe measures designed to mitigate or reverse undesirable effects such as noise, erosion, dust, truck traffic, flooding, ground water level modification, and channel blockage. The description should include plans for landscape restoration, protection of natural drainage channels or development of

[2]A compilation of construction practices is provided in *General Environmental Guidelines for Evaluating and Reporting the Effects of Nuclear Power Plant Site Preparation, Plant and Transmission Facilities Construction*, AIF/NESP-003, February 1974. Copies may be obtained from the Atomic Industrial Forum, Inc., 7101 Wisconsin Avenue, Washington, D.C. 20014.

appropriate substitutes, measures taken to control rainfall runoff, 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.

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

Precautions for handling of fuels, lubricants, oily wastes, and other chemical waste should be included. Describe 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.

CHAPTER 5

ENVIRONMENTAL EFFECTS OF STATION OPERATION

This chapter should describe the interaction of the station 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 station 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.[1] 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 (i.e., the station 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 State and Federal (40 CFR Part 423) effluent guidelines and the thermal standards or limitations applicable to the water body to which the discharge is made (including maximum permissible temperature, maximum permissible increase, mixing zones, and maximum rates of increase and decrease) and whether and to what extent these standards or limitations have been approved by the Administrator of the Environmental Protection Agency in accordance with the Federal Water Pollution Control Act, as amended. Indicate whether the discharge could affect the quality of the 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 that 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

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

the food base that supports them. The evaluation should consider not only the mixing zone, but also the entire regional aquatic habitat potentially affected by operation of the proposed station.

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

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

The applicant should discuss the potential biological effects of modifying the natural circulation of the water bodies affected by the station, 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 station waterflow, the effects should be quantitatively investigated.

Station-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, cooling lakes and ponds, 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, 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. Discuss shadowing effects and esthetic considerations caused by cooling tower plumes. 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 discharged into the atmosphere from nearby fossil-fueled or industrial facilities. (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 or on biota other than man that are attributable to the release of radioactive materials and to direct radiation from the facility. The biota to be considered are those species of local flora and local and migratory fauna defined as "important" in Section 2.2 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 H.) 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 H.) As a minimum, the following pathways should be evaluated: direct radiation from radioactivity contained within the station, shoreline fishing (radionuclides deposited in sediments), immersion in airborne effluents, and radionuclides deposited on the ground surface and vegetation, and internal exposure from inhalation of airborne effluents and from ingestion of milk, drinking water, fish and game, invertebrates, and plants. Identify any additional exposure pathways specific to the region around the site that could contribute 10% or more to either individual or population doses.

5.2.2 Radioactivity in Environment

In Section 3.5, the radionuclide concentrations in the liquid and gaseous effluents discharged from the station 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, (c) on vegetation (on a per unit area basis) in the environs, and (d) in the atmosphere around the nuclear station.

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.

The models and assumptions used to determine air concentration and/or deposition should be described in detail and their validity and accuracy discussed. Guidance on acceptable models is provided in Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion from Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors." The meteorological data used in these models should be identified and consistent with Section 2.3. From the atmospheric transport and diffusion models and meteorological data, provide estimates of relative concentrations (χ/Q), where χ and Q are expressed in units of Ci/m^2 and Ci/yr, respectively, and/or relative annual (or seasonal) deposition (D/Q), where D is expressed in units of Ci/m^2-yr, at points of potential maximum concentration outside the site boundary, at points of estimated maximum individual exposure, and at points within a radial grid of sixteen 22½-degree sectors centered on true north and extending to a distance of 50 miles from the station. A set of data points should be located within each sector at increments of 0.25 mile to a distance of 1 mile from the station, at increments of 0.5 mile from a distance of 1 to 5 miles, at increments of 2.5 miles from a distance of 5 to 10 miles, and at increments of 5 miles thereafter to a distance of 50 miles. Estimates of relative concentration (χ/Q) for noble gas effluents and, if applicable, relative concentration (χ/Q) depleted by deposition and relative deposition (D/Q) for radioiodine and particulate effluents should be provided at each of these grid points. In addition, averages of these χ/Q and/or D/Q values between all adjacent grid points along the radials should be provided.

5.2.2.1 Surface Water Models. Models are herein classified into two categories: those that estimate physical effects using simplifying, conservative assumptions and those that are state-of-the-art attempts at realistically modeling physical effects. Predicting the transport of liquid radioactive effluents may require the use of both categories of models, each applicable under different situations and for different regions of the hydrologic environment. The applicant should discuss the range of applicability of the models used, the methods used in model calibration and verification, the error limits of the resulting predictions, and the input data. Basic hydrologic and station data are discussed in Sections 2.1.3, 2.4, 3.3, 3.4, 3.5, and 6.1. Discussions of the three general types of surface water models (transport, sediment uptake, and water use) that may be used in predicting the effects of liquid radioactive effluents follow.

5.2.2.1.1 Transport Models. Mathematical and/or physical models may be required to predict the transport of liquid radioactive effluents. The size of the region to be simulated and the required level of detail will depend on the radionuclide in question, the quantity released, the surface water pathways, and the temporal and spatial variability of important model parameters (e.g., diffusion coefficients). In cases where significant levels of station-discharged radionuclides remain in the surface waters over large distances, Appendix I to 10 CFR Part 50 requires transport predictions along the surface water pathways ranging from the immediate vicinity of the discharge point to a 50-mile radius of the station.

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

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

For liquid radwaste transport analysis pursuant to Appendix I to 10 CFR Part 50, a tabulation of the expected concentrations and travel times for each of the important radionuclides released to each important pathway to man should be provided on a monthly average basis for conditions anticipated during station operation.

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

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

In those cases where a proposed site is similar or in close proximity to an operating station, anticipated sediment-related effects may be inferred from the results of field measurement programs associated with the operating station.

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

If credit is claimed for concentration reductions of radionuclides resulting from sediment uptake and transport, results should be tabulated separately in the table requested in Section 5.2.2.1.1.

5.2.2.1.3 Water-Use Models. Where water use may affect or be affected by station discharges, computational models may be required to predict projected changes in surface use and flows upstream and downstream (present and projected surface water use is discussed in Section 2.1.3). Such models may be required to predict types of water and temporal variations in use over the life of the station. Predictions will often require the use of models of varying sophistication which are compatible with population projections. In each case the model and input data should be described in detail. Descriptions should include discussions of the applicability and validity of the models with supporting evidence to substantiate the applicant's conclusions. Models of water use are necessary in rivers, lakes, estuaries, and oceans where realistic projections of radionuclide transport are undertaken and where the sensitivity of concentration estimates to assumptions of monthly average flow indicates changes in water use that could significantly change Appendix I to 10 CFR Part 50 objectives. For example, estimates of monthly average flow in a river based solely on historical streamflow records will not indicate the changes in water uses that have occurred historically, nor will they indicate changes to be expected in the future. One way to project flow is to assume that long-term recorded historical runoff conditions adjusted for the effects of man (e.g., reservoirs, diversions, water supply) will be indicative of the future. This adjusted record is then modified for projected water use by man to the end of the station lifetime. The analyses can be undertaken by simulating streamflow and water use sequentially.[2]

5.2.2.2 Ground Water Models. The general categories of models, as described for surface water in Section 5.2.2.1, are also applicable to ground water models. Mathematical models may be used for predicting ground water use and flow and radionuclide transport in aquifers to provide the assessment required by Appendix I to 10 CFR Part 50. For ground water use models, the size of the region to be simulated is the area within 50 miles of the station unless it can be clearly demonstrated that the region within station influence is of smaller extent. For ground water flow and transport models, the size of the region to be simulated and the required level of detail will depend on the radionuclide in question, the quantity released, potential ground water pathways, and temporal and spatial variability of important model parameters (e.g., dispersion coefficients). In general, the size of the simulated region should encompass an area

[2]One such model involving a computer program is "HEC-3, Reservoir Systems Analysis," available from the U.S. Army Corps of Engineers, The Hydrologic Engineering Center, Davis, California.

large enough to reach the nearest significant downgradient surface water body and/or downgradient water supply wells within 50 miles of the station.

Transport predictions will often require the use of different models, each applicable to a given region of the ground water pathway. In each case, the model should be described in detail. The description of the model should include justification of all model input data and assumptions. The applicant should describe in detail the methods employed to obtain model parameters such as dispersion and distribution (sorption) coefficients. Data for model parameters should be presented in Section 2.4. The techniques and results of both laboratory and field calibration and verification studies, including sensitivity analysis, should be presented for each model.

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 (1) the maximum radionuclide concentrations that may be present in important local flora and local and migratory fauna and (2) the internal dose rates (millirad/year) that may result from those concentrations. Values of bioaccumulation factors[3] 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 (in terms of man-hours) on recreational and similar use of receiving water and its shoreline, e.g., fishing, picnicking, hunting, clam digging within 50 miles of the site. 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 acres of limited dilution, provide data on means to provide temporary water supply from storage or alternative sources.

Determine the expected radionuclide concentrations in aquatic and terrestrial organisms significant to human food chains. (Information and data on aquatic and terrestrial organisms are requested in Section 2.1.3.) Use the bioaccumulation factors given in Section 5.2.3, or supply others as necessary.

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 the total body and thyroid doses (millirem/year) and significant doses received by other organs via such potential pathways,[4] including direct radiation from surface-deposited radionuclides.

Provide an appendix describing the transport and dose models used in these calculations.[4, 5]

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 site boundary (as defined in Section 2.1.1.2) and the dose rate at the most critical nearby residences, as well as schools, hospitals, or other publicly used facilities within one mile of the

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[3]The bioaccumulation factor for aquatic organisms 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. Values of bioaccumulation factors for terrestrial organisms can be obtained from Y.C. Ng. et al., *Prediction of the Maximum Dosage to Man from the Fallout of Nuclear Devices – IV, Handbook for Estimating the Maximum Internal Dose from Radionuclides Released to the Biosphere*, USAEC Report, UCRL-50163, Pt. IV, Lawrence Radiation Lab., University of California, Livermore, CA, 1968.

[4]Models and assumptions for calculating doses are described in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I."

[5]Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion for Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors."

proposed nuclear unit(s). A summary of data, assumptions, and models used in the dose calculations should be given.

5.2.4.4 Annual Population Doses. Using the above information and any other necessary supporting data, calculate the annual total-body man-rem dose and the annual man thyroid-rem dose to the population expected to reside within the 50-mile region at the mid-point of station operation. Also calculate the annual total-body man-rem dose and the annual man thyroid-rem dose received by the population of the contiguous U.S. at the same time from all liquid and gaseous exposure pathways. Provide an appendix describing the models and assumptions used in these calculations.

5.2.5 Summary of Annual Radiation Doses

The applicant should present a table that summarizes the estimated annual radiation dose to the regional population (during commercial operation of the station) from all station-related sources, using values calculated in previous sections. The tabulation should include, out to a distance of 50 miles from the site, (a) the total of the whole-body doses to the population (man-rem/year) from all receiving-water-related pathways, (b) the total of the whole-body doses to the population (man-rem/year) attributable to gaseous effluents, and (c) the total of the thyroid doses to the population (thyroid-rem/year) from radioiodines and particulates. The applicant should include a table comparing the calculated individual doses with the applicable design objectives of Appendix I to 10 CFR Part 50.

5.3 Effects of Chemical and Biocide Discharges

Chemical and biocide discharges and comparisons with applicable State and Federal (40 CFR Part 423) effluent limitation guidelines 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 applicable State water quality standards, and, where appropriate, with water quality criteria for the protection of all other uses of the receiving water body.

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., streamflow, temperature) of receiving water should be discussed.

The effects on the environment of chemicals in the station's cooling system effluents (including cooling tower blowdown and drift) should also be considered in this section. Using the design discharge contaminant concentrations (see Section 3.6), estimate the resulting stream concentrations at various distances and water flow variations (including the average 7-day, once-in-10-years low flow, normal flow conditions, the lowest control flow, and the lowest recorded minimum for the receiving water body), and compare, in tabular form, the resulting stream concentrations to State water quality standards. Include a description of the method of calculation.

The applicant should furnish sufficient data and information to allow the NRC to fulfill its responsibilities under NEPA. Calculated receiving water concentrations should also be compared with water quality criteria appropriate to the protection of actual uses of the receiving water body.[6]

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.

If available, applicants should supply copies of the 401 water quality certificate and the 402 discharge permit.

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 transmission

[6]Applicants are encouraged to reference the latest scientific information related to water quality criteria. Other useful documents include: *Water Quality Criteria, 1972,* National Academy of Sciences-National Academy of Engineering, Washington, D.C., 1972 and *Water Quality Criteria,* Second Edition, State Water Quality Control Board, Sacramento, California, 1963.

line 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 ensuring 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 identified in Section 3.9 and any operating and maintenance impacts that will be adopted to minimize these.

5.6 Other Effects

The applicant should discuss any effects of station 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 station site, interaction of the station with other existing or projected neighboring stations, effect of ground water withdrawal on ground water resources in the vicinity of the station, and disposal of solid and liquid wastes other than those discussed in Sections 5.3 and 5.4. Any features of the station producing noise levels outside the suggested levels[7] should be specifically identified and discussed in relation to adjacent occupancy, both day and night, based on measurements of preconstruction ambient levels.

5.7 Resources Committed

Any irreversible and irretrievable commitments of resources due to station 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 station should be examined with the view of determining whether they represent long-term net losses or long-term net gains. The above considerations are also applicable to Chapters 9 and 10 of the report.

5.8 Decommissioning and Dismantling

The applicant should describe its plans and policies regarding the actions to be taken at the end of the station'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 station 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 station operation is, in part, determined by station design, applicants should give attention to the subject in the project planning.

5.9 The Uranium Fuel Cycle

~~The environmental report for light-water-cooled reactors should contain the environmental effects of the uranium fuel cycle, including the effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, the reprocessing of irradiated fuel, the transportation of radioactive materials, and management of low-level and high-level wastes related to the uranium fuel activites, as set forth in Summary Table S-3 of 10 CFR Part 51, §51.20 (see Appendix A). No further discussion of such environmental effects in the environmental report is needed~~. Deleted August 1976

[7]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

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

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

The applicant should note two considerations pertinent to Section 6.1. First, a given environmental characteristic or parameter may or may not require assessment before site preparation and station construction, depending on whether that particular characteristic or parameter 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 environmental parameters that must be subsequently monitored during station operation (discussed in Section 6.2), as well as during site preparation and station construction.

If, as permitted by 10 CFR Part 2, §2.101(a), the applicant chooses to make an early separate filing of the environmental report prior to obtaining and evaluating a full year's environmental data, particular attention should be paid to the description of sampling design, sampling frequency, and statistical methodology and validity (including calibration checks and standards) in order to justify the scope of the proposed program, the timing and scheduling of the data collection, and other technical validation that will assure the review staff that sufficient information will be available for the preparation of the Final Environmental Statement.

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

In all cases, 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 descriptions of samples collected within each area of interest and each time of interest, descriptive statistics should include, unless justifiably omitted, the mean, standard deviation, standard error, and a confidence interval for the mean. In each case the sample size should be clearly indicated. If diversity indices are used to describe a collection of lake or terrestrial organisms, the specific diversity indices used 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.[1] In all cases, information derived from published results should be clearly distinguished from information derived from the applicant's field measurements.

[1] 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.

6.1.1 Surface Waters

When a body of surface water may be affected by the proposed facility or a practicable alternative, the applicant should describe the programs by which the background condition of the water and the related ecology were determined and reported in Section 2.4. 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 that may be affected by construction or operation of the facility should be described. The sampling program should be presented in sufficient detail to demonstrate its adequacy with respect both to spatial coverage (surface area and depth) and to temporal coverage (duration and sampling frequency), giving due consideration to seasonal effects. This discussion should include a description of the techniques used to investigate any condition that might lead to interactions with station discharges, such as how the presence of impurities in a water body may react synergistically with heated effluent or how the heated effluent may restrict mixing and dispersion of radioactive effluents. The applicant should describe any computational models and their bases and verification used in predicting effects described in Section 5.2.2.1.

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 ensured.

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

The applicant should discuss the basis for its predictions of any nonlethal physiological and behavioral responses of important species which may be caused by construction or operation of the station. 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 station 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 or in which the ground water environment may serve as a pathway to man, either directly or indirectly, the program leading to assessment of potential effects should be described.

6.1.2.1 Physical and Chemical Parameters. The properties and configuration of the local aquifer, variations (spatial and temporal) in ground water levels, and ground water quality data are discussed in sufficient detail in Section 2.4 to permit a reasonable projection of the effects of station operation on the ground water. The methods used to obtain and reduce the data presented in Section 2.4 should be described, including instrumentation (suggested criteria will be presented in a forthcoming regulatory guide on hydrologic data collection).

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 and local and regional meteorology. Guidance on an acceptable onsite meteorological measurement program and on data format is presented in Regulatory Guide 1.23 (Safety Guide 23), "Onsite Meteorological Programs." The description should show the basis for predicting such effects as the dispersion of gaseous effluents to a distance of 50 miles from the station and the alteration of local climate (e.g., fogging, icing, precipitation augmentation, or other phenomena) and should present the methodology for gathering baseline data.

6.1.3.1 Meteorology. The applicant should identify sources of meteorological data used in the atmospheric transport models and 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 the applicant's preoperational and operational programs, the applicant should include descriptions of instruments, performance specifications, calibration and maintenance procedures, data output and recording systems and locations, and data analysis procedures.

6.1.3.2 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 in detail and their validity and accuracy discussed. Guidance on acceptable atmospheric transport and diffusion models is provided in Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion for Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors."

6.1.4 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 its program 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 (Section 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 Section 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 Environmental Report–Construction Permit Stage. Specific information should be provided on (a) the types of samples to be collected, (b) sampling locations clearly shown on a map keyed to a table listing sampling locations as a function of direction and distance from the proposed site, (c) analyses to be performed on each sample, (d) general types of sample collection equipment, (e) sample collection and analysis frequency, (f) lower limit of detection[2] for each analysis, and (g) the approximate starting date and duration of the program. The discussion should include the justification for the choice of sampling sites, analyses, and sampling frequencies. Review of this description will be facilitated if the applicant presents a tabular summary of the program.

The applicant should also describe how it expects to extend the preoperational program into the operational phase and in what manner the results of the preoperational program may be used to effect the design of the operational program. Guidance for both the preoperational program and operational program is provided in Regulatory Guide 4.1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants." Additional guidance is provided in Regulatory Guide 4.8, "Environmental Technical Specifications for Nuclear Power Plants." In addition, EPA report ORP/SID 72.2, *Environmental Radioactivity Surveillance Guide*, recommends methods for conducting a minimum level of environmental radiation surveillance outside the station 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).[3]

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.

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

[3]A report on this subject by the National Council on Radiation Protection and Measurements is available; *Natural Background Radiation in the United States*, NCRP Report No. 45. Copies may be obtained from Publications, NCRP, P.O. Box 30175, Washington, D.C. 20014.

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 its intended programs and provide a tentative listing of parameters that it believes should be monitored for detailed evaluation. This listing should include numerical excerpts from water or air standards against which the proposed monitoring program will be measured as understood at the time of initial submission of the environmental report. The listing should also include parameters that are important for the models described in Sections 5.2.2.1 and 5.2.2.2, as required in Section IV of Appendix I to 10 CFR Part 50.

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

In the Environmental Report–Construction Permit Stage, the operational program need only be discussed to the extent that it is expected to differ (if at all) from the ongoing preoperational program, such as the inclusion of a census of dairy cattle and vegetable gardens. If, in the Environmental Report–Operating License Stage, there are no differences between the preoperational programs (as finally formulated) and the 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 station 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 agencies or other agencies not directly supported by the applicant, any such related programs known to the applicant should be identified and discussed. Relevance of such independent findings to the proposed facility's effects should be described, and plans for exchange of information, if any, should be presented. Agencies responsible for the programs should be identified and, to the extent possible, the procedures and methodologies employed should be briefly described. These agencies may have developed and verified mathematical or physical models that encompass the site area and the surrounding water environs comparable to those discussed in Sections 5.2.2.1 and 5.2.2.2. Such models may be used either directly or with minor modifications. When such models are used in support of liquid transport analyses of radionuclide releases, the same data and technical bases as suggested in Sections 5.2.2.1 and 5.2.2.2 should be furnished.

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[4] of preoperational environmental radiological monitoring data.

[4]The minimum amount of preoperational data may be submitted if it includes data from a crop harvest and a complete grazing season. All media with a collection frequency less than semiannual (e.g., annual or once in 3 years) should be included in the 6 to 12 months of data submitted.

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 (36 FR 22851). Appendix D of 10 CFR Part 50 has been superseded by 10 CFR Part 51; however, Part 51 does not affect the status of the proposed Annex to Appendix D of 10 CFR Part 50. (See Appendix I of this guide for this Annex.)

Applicants may, for purposes of environmental reports, take the option in the calculation of χ/Q values of using either of two meteorological 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, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors," or Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors."

7.2 Transportation Accidents Involving Radioactivity

The requirements for analysis of environmental risk from accidents involving the transportation of radioactive materials to and from nuclear power reactors are contained in 10 CFR Part 51. If the transportation of fuel and wastes to and from nuclear power reactors is within the scope of paragraph (g) of §51.20, the environmental report need only contain a statement that such environmental risks are as set forth in Summary Table S-4 of 10 CFR Part 51 (see Appendix A). No further discussion of environmental risks concerning the transportation of radioactive materials is needed in the environmental report.

If the transportation of fuel and waste to and from nuclear power reactors is not within the scope of paragraph (g) of §51.20, a full description and detailed analysis of the environmental risk from accidents should be provided. An analysis of the environmental risks from accidents in the transportation of radioactive materials to and from nuclear power reactors following the approach set forth in WASH-1238 is acceptable.[1]

7.3 Other Accidents

In addition to accidents that can release radioactivity to the environs, accidents may occur as a result of station operation that, although they do not involve radioactive materials, have consequences that may affect the environment. Accidents such as chemical explosions, fires, and leakage or ruptures of vessels containing oil or toxic materials can have significant environmental impact. These possible accidents and associated effects should be identified and evaluated (see Section 2.2 of Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants").

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[1] An analysis of the environmental risks from accidents in the transportation of radioactive materials to and from nuclear power reactors is given in WASH-1238, *Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants*, December 1972, and Supplement I to WASH-1238, NUREG-75/038, April 1975. Both documents may be obtained from the National Technical Information Service, Springfield, Virginia 22161.

CHAPTER 8

ECONOMIC AND SOCIAL EFFECTS OF STATION CONSTRUCTION AND OPERATION

This chapter should present the applicant's assessment of the economic and social effects of the proposed nuclear 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 or 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.[1]

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 station are those inherent in the value of the generated electricity delivered to consumers. The applicant should report, as shown in Table 1, 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.*[2]

The importance of the proposed station 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 station (or its equivalent capacity) is not built by the proposed date should be estimated. The applicant should also 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. If benefits are claimed for recreational uses of the proposed nuclear station site, the effect of any plan to place additional generating units at the site at some future time should be discussed.

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 stations. 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 that 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 esthetic 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 station operation,

[1]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).

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

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 educational facilities (e.g., a visitors' center).

• Annual savings in consumption of imported crude oil for power generation.

The applicant should discuss significant benefits that may be realized from the construction and operation of the proposed station. Where the benefits can be 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 esthetic impacts that are difficult to quantify, the applicant should provide illustrations of significant station structures or environmental modifications visible to the public in addition to 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 station and its operation are likewise complex and should be quantified wherever possible.

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 station and its operation and maintenance. The applicant should discount these costs to present worth.

The applicant should provide the types of information listed in Table 2 for nuclear and alternative power generation methods. (Alternative power generation methods are discussed in detail in Chapter 9.) If the applicant includes a coal-fired plant as a viable alternative to a nuclear power station, information should be provided for both a coal-fired plant with sulfur removal equipment and one that burns low-sulfur coal.

In Table 2, items (1) through (5) are necessary to run the CONCEPT[3] code used by the NRC staff. Inclusion of this information in the applicant's environmental report could expedite the staff's review process. Item (6) would permit the staff to compare detailed cost categories to distinguish any significant differences that might exist between the applicant's estimate and the CONCEPT model.

The environmental report should include the estimated cost of generating electric energy in mills per kilowatt-hour for the proposed nuclear station and for alternative fossil-fueled plants in the detail shown in Table 3. (Alternative energy sources are discussed in Chapter 9.) 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.[4] 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[5] include: shortages of housing; inflationary rentals or prices; congestion of local streets and highways; noise and temporary esthetic disturbances; overloading of water supply and sewage treatment facilities; crowding of local schools, hospitals, or other public facilities; overtaxing of community services; and the disruption of people's lives or the local community caused by acquisition of land for the proposed site.

Long-term external costs[6] include impairment of recreational values (e.g., reduced availability of desired species of wildlife and sport fish, restrictions on access to land or water areas preferred for recreational use); deterioration of esthetic 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

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[3]H. I. Bowers and I. T. Dudley, *Multi-Unit Power Plant Cost Models For the Concept Code,* ORNL-TM-4300, July 1974, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830 (and references therein).

[4]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.

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

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

contemplated alternative uses; creation of locally adverse meteorological conditions (e.g., fog and plumes from cooling towers, cooling lakes and ponds); creation of noise, especially by mechanical-draft cooling towers; reduction of regional products due to displacement of persons from the land proposed for the site; lost income from recreation or toursim 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; and 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.

CHAPTER 9
ALTERNATIVE ENERGY SOURCES AND SITES

This chapter should 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 the considerations and rationale that led 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 to reveal suitable site-plant combinations which were then subjected to a detailed cost-effectiveness comparison to make the final site selection.

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 that do not require the creation of additional generating capacity should be identified and evaluated.[1] Such alternatives may include, but not be limited to, 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.

[1]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[2]

In this section, the applicant should present an initial survey of site availability using any methodology that surveys the entire region available to the applicant and that, after identifying areas containing possible sites, eliminates those whose less desirable characteristics are recognizable without extensive analysis. The purpose of this site selection process is to identify a reasonable number of realistic siting options. To ensure that realistic alternatives are presented, two or more candidate areas should be chosen for detailed comparison with appropriate site-plant combinations. In assessing potential candidate areas, the applicant may place primary reliance on published materials[3] and reconnaissance level information. Guidance on the selection of potential sites for nuclear stations is presented in Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations." The applicant may wish to use the following definitions in discussing its site selection process:

- *Region of Interest.* The geographical area initially considered in the site selection process. This area may represent the applicant's system, the power pool or area within which the applicant's planning studies are based, or the regional reliability council or the appropriate subregion or area of the reliability council.

- *Candidate Areas.* Reasonable homogeneous areas within the region of interest investigated for potential sites. Candidate areas may be made up of a single large area or several unconnected ones. The criteria governing a candidate area are the same resources and populations on which the potential plant would have an impact and similar facility costs.

- *Potential Sites.* Sites within the candidate areas that have been identified for preliminary assessment in establishing candidate sites.

- *Candidate Sites.* Sites suitable for evaluation by the applicant during the process of selecting a proposed site. To be a candidate site, the site must be considered to be potentially licensable and capable of being developed.

- *Proposed Sites.* Sites for which an applicant seeks a license to construct and operate a power station.

[2]As used in this chapter, the term *area* is defined as several square miles (large enough to contain several sites).

[3]Several methods of site selection and evaluation may be found in *Nuclear Power Plant Siting–A Generalized Process,* AIF/NESP-002, Atomic Industrial Forum, August 1974. Copies may be obtained from Atomic Industrial Forum, Inc., 7101 Wisconsin Avenue, Washington, D.C. 20014.

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 station 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,[4] 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). The maps 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 (e.g., mountains, marshes, fault lines);

6. Dedicated land-use areas (e.g., parks, historical sites, wilderness areas, testing grounds, airports);

7. Valuable agricultural, residential, recreational, or industrial areas that may be impacted;

8. Primary generating plants, together with effective operating capacity in megawatts, both electrical and thermal, and indication of fuel (all generating units of the same fuel type at the same location should be considered a single source);

9. Other generating additions to the network to be installed before the proposed nuclear facility goes on line;

10. Transmission lines of 115 kV or more and termination points on the system for proposed and potential lines from the applicant's proposed facility (with emphasis on new rights-of-way); and

11. Major interconnections with other power suppliers (with emphasis on new rights-of-way).

These considerations may be expanded to include appropriate factors such as those discussed in Regulatory Guide 4.7.

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 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. Hydroelectric and geothermal sources should also be considered if available. In some situations, combinations of energy sources (e.g., coal-fired baseload units plus gas-turbine peaking units may be practical alternatives. The discussion should clearly establish the energy-source alternatives.

Long-term supplies and forecasted costs of each realistic fuel alternative should be stated. The nature of any supply restriction should be specified as to physical shortages, environmental controls, international trade restrictions, or other factors.

Using the materials described above, the applicant should provide a condensed description of the major considerations that led to the final selection of the candidate areas. These candidate areas should constitute a complete but realistic listing of areas in which it would be feasible to site a power generation facility. While the number of suitable locations for any one siting consideration may be large, the comparison of factors may constrain the final list of candidate areas to a small number with each area displaying several favorable characteristics.

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

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

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. Current use of the land should be documented and the potential for preempting other high valued uses of land such as agriculture, recreation, residences, or industry should be noted.

10. The availability of a labor pool for power plant construction within commuting distance should be estimated.

9.2.2 Selection of Candidate Site-Plant Alternatives[5]

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. If the site is currently, or expected to be, used for agriculture, its soil class should be reported according to the U.S. Soil Conservation Service Soil Classification System,[6] and the number of acres should be indicated. Furthermore, although a particular geographical area may have been judged unsuitable for consideration as a candidate area because of one major overriding disadvantage, the establishment of the suitability of a given site-plant combination will (except for choice of fuel) 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-Effectiveness Analysis 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. 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 guide for use in comparing the alternatives and the proposed facility. The criteria chosen by the applicant should reflect benefits and costs[7] that were evaluated in

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

[6]U.S. Department of Agriculture, *Land-Capability Classification*, Agriculture Handbook No. 210, 1973, U.S. Government Printing Office, Washington, D.C.

[7]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.

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
- Water quality
- Sensitivity of aquatic and terrestrial habitats affected
- Commitment of resources
- Dedicated areas
- Projected recreational usage
- Scenic values

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
- Fuel costs (annual)
- Operating and maintenance costs (annual)

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.

9.4 Costs of Alternative Power Generation Methods

The applicant should provide cost information for alternative power generation methods and the proposed nuclear station. (Costs for the proposed nuclear station are discussed in Chapter 8.)

In order to supplement the economic information provided in Chapter 8 of the environmental report, the cost information shown in Table 2 should be provided for (1) coal-fired units (one use that would utilize low-sulfur coal and a second that would use high-sulfur coal with stack gas cleaning), (2) oil-fired units, and (3) nuclear power units.

The environmental report should also include the estimated cost of generating electric energy in mills per kilowatt-hour for the proposed nuclear station and for alternative fossil-fueled plants in the detail shown in Table 3. 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.

CHAPTER 10
STATION DESIGN ALTERNATIVES

This chapter should show how the applicant arrived at the design of the proposed station through consideration of alternative designs of identifiable systems and through their comparative assessment.

The significant environmental interfaces of a nuclear power station will be associated with the operation of certain identifiable systems. The applicant's proposed station should incorporate a combination of these identifiable systems, each of which has been selected through a cost-effectiveness analysis 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 station 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)[1]
- Chemical waste treatment[1]
- Sanitary waste system
- 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:

1. **Range of alternatives.** The applicant's discussion should emphasize those alternative station 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 that comply with 40 CFR Part 423 but that are a better environmental solution, taking into account impacts on air quality, esthetics, etc.) and (2) although not necessarily economically attractive, they are based on feasible technology available to the applicant during the design state.

In cases where the system proposed in the application does not comply with thermal effluent limitations under Sections 301 and 306 of Public Law 92-500 [the Federal Water Pollution Control Act (FWPCA) as amended] and no disposition of any request for waiver under Section 316(a) is expected until after issuance of a construction permit, the environmental report should clearly identify the most feasible alternative cooling system that would be selected in the event that alternative thermal effluent limitations are not imposed.

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

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

4. **Monetized costs.** The acquisition and operation costs of individual systems and their alternatives (as well as costs of the total station 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 4. 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.[2]
- Interest to the date of operation on all expenditures prior to that date.

[1]Systems that are subject to effluent limitation guidelines and new source performance standards of 40 CFR Part 423.

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

• Expenditures subsequent to the scheduled date of operation discounted to that date. In calculations, the applicant should assume a 30-year station life.[3]

In computing the annualized present value of station 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 station
- Taxes
- Insurance costs
- Cost of modification or alteration of any other station system if required for accommodation of alternatives to maintain station capacity (see Item 2 above)
- Maintenance costs for the transmission facility (if applicable)
- Cost of supplying makeup power during a delay resulting from an alternative design choice that will not meet the power requirement by the scheduled inservice date.

5. **Environmental costs.** Environmental effects of alternatives should be documented and supported by available information. To the extent practicable, the magnitude of each effect should be quantified. Where quantification is not possible, qualitative evaluations should be expressed in terms of 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 5 presents a set of environmental factors that should be considered in comparing alternative station systems in the cost-effectiveness analysis. Although incomplete, the factors listed are believed to represent the principal environmental effects of power station construction and operation that can be evaluated by generally accepted techniques. The table provides for three key elements of environmental cost evaluation:

a. A description of each effect to be measured (Column 3).

b. Suggested units to be used for measurement (Column 4). The NRC recognizes the difficulty, if not the impossibility, of using the assigned units for every item in Table 5 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.

c. A suggested methodology of computation (Column 5). Computation of effects in response to each block in Table 5, 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 5 (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 the 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.

6. **Supporting details.** In the following sections, the applicant should discuss design alternatives for each of the relevant station systems (e.g., cooling system, intake system). The discussion should describe each alternative, present estimates of its environmental impact, and 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 station systems should be limited in scope to those efforts required to support the cost-effectiveness analysis that led to selection of the proposed design.

7. **Presentation of alternative designs.** The results should be tabulated for each station system in a format consistent with the definitions in Table 5.

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

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

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.

When an applicant proposes to create a lake or pond for primary cooling, the environmental report at the construction permit stage should consider the effects of variations in the size of the cooling reservoir on the performance of the power station, the environmental impacts (including the loss of agricultural lands and woodlands and the products therefrom and the impacts on terrestrial and aquatic life), and the economic costs. The environmental report should also discuss the matter of making the cooling reservoir and its surroundings a multiple-use facility, including a public recreational resource, and should present the reasons for the decision in favor of or opposing such a development.

If the applicant decides to provide a recreational facility, the environmental report at the construction permit stage should contain a general plan to provide for public recreational use. The specific plan for public recreational use should be provided at the operating license stage. The plan should include a discussion of recreational needs in the area; a description (including maps and artist conceptions) of the proposed recreational facilities, lake management and fisheries stocking program, and associated landscaping; a schedule of installation, estimated costs of construction, operation and maintenance, and the source of funds to pay these costs; and estimated public use of the facilities. Describe the participation in planning, if any, by local, State, and Federal governments. A commitment to implement the plan must be made if the potential benefit is considered in balancing the costs and benefits.

10.2 Intake System

The applicant should identify and describe alternatives to the proposed intake system design, such as shoreline and offshore intakes, traveling screens (vertical, horizontal, angle-mounted, single entry–double exit), barriers (lower, electric, sound, light, bubble), perforated-pipe intakes, and infiltration-bed intakes. Estimates of environmental effects should be prepared and tabulated. Alternatives should be referenced to any requirements for intake systems imposed under Section 316(b) of 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 that 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 Appendix I of 10 CFR Part 50, 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 in Appendix I. In any case, for reactors to which Appendix I does not apply, the applicant should demonstrate sufficient consideration of alternative radwaste systems and their radiological output to ensure that releases from the proposed facility will be as low as is reasonably achievable.

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 station 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.

CHAPTER 11
SUMMARY COST-BENEFIT ANALYSIS

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

Although the cost-benefit analysis approach discussed in this guide is conceptually similar to the cost-benefit 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 costs versus benefits 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 cost-benefit 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 that will be considered in the NRC's Environmental Statement. In selecting each proposed station 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. Second, the applicant should consider generating, environmental, and other cost items identified in Chapters 4, 5, 8, 9, and 10; 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 station 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 station 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 (FWPCA), 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 (FWPCA) for alternative effluent limitations should be explained.

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

In view of the effects of the station 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[1] identifies the State, metropolitan, and regional clearinghouses[2] that should be contacted as appropriate.

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

[2]A listing of the clearinghouses that serve a particular site area may be obtained from the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Site Safety and Environmental Analysis, Washington, D.C. 20555.

CHAPTER 13

REFERENCES

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

References should be cited by numerical designation and listed at the end of the chapter to which they refer.

TABLES

TABLE 1

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 2

COST INFORMATION FOR NUCLEAR AND ALTERNATIVE POWER GENERATION METHODS

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 Station Cost[a]

Direct Costs	Unit 1	Unit 2
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 equipment	________	________
h. Spare parts allowance	________	________
i. Contingency allowance	________	________
Subtotal	________	________

Indirect Costs	Unit 1	Unit 2
a. Construction facilities, equipment, and services	________	________
b. Engineering and construction management services	________	________
c. Other costs	________	________
d. Interest during construction (@________ %/year)	________	________
Escalation		
Escalation during construction @________ %/year	________	________
Total Cost		
Total Station Cost, @ Start of Commercial Operation	________	________

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[a]Cost components of nuclear stations 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, available from National Technical Information Service, Springfield, Virginia 22161.

TABLE 3

ESTIMATED COSTS OF ELECTRICAL ENERGY GENERATION

	Mills/Kilowatt-Hour
Fixed Charges[a]	
Cost of money	________
Depreciation	________
Interim replacements	________
Taxes	________
Fuel Cycle Costs[b]	
For fossil-fueled plants, costs of high-sulfur coal, low-sulfur coal, or oil	________
For nuclear stations:	
Cost of U_3O_8 (yellowcake)	________
Cost of conversion and enrichment	________
Cost of conversion and fabrication of fuel elements	________
Cost of processing spent fuel	________
Carrying charge on fuel inventory	________
Cost of waste disposal[c]	________
Credit for plutonium or U-233	________
Costs of Operation and Maintenance[d]	
Fixed component	________
Variable component	________
Costs of Insurance	
Property insurance	________
Liability insurance	________

[a] Give the capacity factor assumed in computing these charges, and give the total fixed-charge rate as a percentage of station investment.
[b] Include shipping charges as appropriate. Give the heat rate in Btu/kilowatt-hour.
[c] If no costs are available, the applicant may use the cost assumptions as listed in the most recent publication of *Nuclear Industry*.
[d] 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.

TABLE 4

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 station 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 that 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 station.
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 stations
[b]Delay to be computed from the time of filing for a construction permit (10 CFR Part 51, § 51.20)

TABLE 5

ENVIRONMENTAL FACTORS TO BE USED IN COMPARING ALTERNATIVE STATION SYSTEMS (Page 1 of 16)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
1. NATURAL SURFACE WATER BODY	(Specify natural water body affected)			
1.1 Impingement or entrapment by cooling water intake structure	1.1.1 Fish[b]	Juveniles and adults are subject to attrition.	Percent of harvestable or adult population destroyed per year for each important species	Identify all important species as defined in Section 2.2. Estimate the annual weight and number of each species that will be destroyed. (For juveniles destroyed, only the expected population that would have survived naturally need be considered.) Compare with the estimated weight and number of the species population in the water body.
1.2 Passage through or retention in cooling systems	1.2.1 Phytoplankton and zooplankton	Plankton population (excluding fish) may be changed due to mechanical, thermal, and chemical effects.	Percent changes in production rates and species diversity	Field studies are required to estimate (1) the diversity and production rates of readily recognizable groups (e.g., diatoms, green algae, zooplankton) and (2) the mortality of organisms passing through the condenser and pumps. Include indirect effects[c] which affect mortality.

[a]Applicant may substitute an alternative unit of measure where convenient. Such a measure should be related quantitatively to the unit of measure shown in this table.
[b]*Fish* as used in this table includes shellfish and other aquatic invertebrates harvested by man.
[c]Indirect effects could include increased disease incidence, increased predation, interference with spawning, changed metabolic rates, hatching of fish out of phase with food organisms.

TABLE 5 (Page 2 of 16)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
	1.2.2 Fish	All life stages (eggs, larvae, etc.) that reach the condenser are subject to attrition.	Percent of harvestable or adult population destroyed per year for each important species	Identify all important species as defined in Section 2.2. Estimate the annual weight and number of each species that will be destroyed. (For larvae, eggs, and juveniles destroyed, only the expected population that would have survived naturally need be considered.) Compare with the estimated weight and number of the species population in the water body.
1.3 Discharge area and thermal plume	1.3.1 Water quality, excess heat	The rate of dissipation of the excess heat, primarily to the atmosphere, will depend on both the method of discharge and the state of the receiving water (i.e., ambient temperature and water currents).	Acres and acre-feet	Estimate the average heat in Btu's per hour dissipated to the receiving water at full power. Estimate the water volume and surface areas within differential temperature isotherms of 2, 3, and 5°F under conditions that would tend, with respect to annual variations, to maximize the extent of the areas and volumes.
	1.3.2 Water quality, oxygen availability	Dissolved oxygen concentration of receiving waters may be modified as a consequence of changes in the water temperature, the translocation of water of different quality, and aeration.	Acre-feet	Estimate volumes of affected waters with concentrations below 5, 3, and 1 ppm under conditions that would tend to maximize the impact.
	1.3.3 Fish (nonmigratory)	Fish[b] may be affected directly or indirectly because of adverse conditions in the plume.	Net effect in pounds per year (as harvestable or adult fish by species of interest)	Field measurements are required to establish the average number and weight (as harvestable or adults) of important species (as defined in Section 2.2). Estimate their mortality in the receiving water from direct and indirect effects.[c]

TABLE 5 (Page 3 of 16)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
	1.3.4 Wildlife (including birds and aquatic and amphibious mammals and reptiles)	Suitable habitats (wetland or water surface) may be affected	Acres of defined habitat or nesting area	Determine the areas impaired as habitats because of thermal discharges, including effects on food resources. Document estimates of affected population by species.
	1.3.5 Fish (migratory)	A thermal barrier may inhibit migration, both hampering spawning and diminishing the survival of returning fish.	Pounds per year (as adult or harvestable fish by species of interest)	Estimate the fraction of the stock that is prevented from reaching spawning grounds because of station operation. Prorate this directly to a reduction in current and long-term fishing effort supported by that stock. Justify estimate on basis of local migration patterns, experience at other sites, and applicable State standards.

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
1.4 Chemical effluents	1.4.1 Water quality, chemical	Water quality may be impaired.	Acre-feet, %	The volume of water required to dilute the average daily discharge of each chemical to meet applicable water quality standards should be calculated. Where suitable standards do not exist, use the volume required to dilute each chemical to a concentration equivalent to a selected lethal concentration for the most important species (as defined in Section 2.2) in the receiving waters. The ratio of this volume to the annual minimum value of the daily net flow, where applicable, of the receiving waters should be expressed as a percentage and the largest such percentage reported. Include the total solids if this is a limiting factor. Include in this calculation the blowdown from cooling towers and other closed-cycle cooling systems.
	1.4.2 Fish	Aquatic populations may be affected by toxic levels of discharged chemicals or by reduced dissolved oxygen concentrations.	Pounds per year (by species of fish)	Total chemical effect on important species of aquatic biota should be estimated. Biota exposed within the facility, as well as biota in receiving waters, should be considered. Supporting documentation should include reference to applicable standards, chemicals discharged, and their toxicity to the aquatic populations affected.

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
	1.4.3 Wildlife (including birds and aquatic and amphibious mammals and reptiles)	Suitable habitats for wildlife may be affected.	Acres	Estimate the area of wetland or water surface impaired as a wildlife habitat because of chemical contamination, including effects on food resources. Document the estimates of affected population by species.
	1.4.4 People	Recreational water uses (boating, fishing, swimming) may be inhibited.	Lost annual user days and area (acres) or shoreline miles for dilution	The volume of the net flow to the receiving waters required for dilution to reach accepted water quality standards must be determined on the basis of daily discharge and converted to either surface area or miles of shore. Cross-sectional and annual minimum flow characteristics should be incorporated where applicable. The annual number of visitors to the affected area or shoreline must be obtained. This permits estimation of lost user-days on an annual basis. Any possible eutrophication effects should be estimated and included as a degradation of quality.
1.5 Radionuclides discharged to water body	1.5.1 Aquatic organisms	Radionuclide discharge may introduce a radiation level that adds to natural background radiation.	Rad per year	Sum dose contributions from radionuclides expected to be released.

TABLE 5 (Page 6 of 16)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
	1.5.2 People, external	Radionuclide discharge may introduce a radiation level that adds to natural background radiation for water users.	Rem per year for individual; man-rem per year for estimated population at the midpoint of station operation	Sum annual dose contributions from nuclides expected to be released.
	1.5.3 People, ingestion	Radionuclide discharge may introduce a radiation level that adds to natural background radiation for ingested food and water.	Rem per year for individuals (whole body and organ); man-rem per year for population at the midpoint of station operation	Estimate biological accumulation in foods and intake by individuals and population. Calculate doses by summing results for expected radionuclides.
1.6 Consumptive use	1.6.1 People	Drinking water supplies drawn from the water body may be diminished.	Gallons per year	Where users withdraw drinking water supplies from the affected water body, lost water to users should be estimated. Relevant delivered costs of replacement drinking water should be included.
	1.6.2 Agriculture	Water may be withdrawn from agricultural usage, and use of remaining water may be degraded.	Acre-feet per year	Where users withdraw irrigation water from the affected water body, the loss should be evaluated as the sum of two volumes: the volume of the water lost to agricultural users and the volume of dilution water required to reduce concentrations of dissolved solids in station effluent water to an agriculturally acceptable level.

TABLE 5 (Page 7 of 16)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
	1.6.3 Industry	Water may be withdrawn for industrial use.	Gallons per year	
1.7 Plant construction (including site preparation)	1.7.1 Water quality, physical	Turbidity, color, or temperature of natural water body may be altered.	Acre-feet and acres	The volume of dilution water required to meet applicable water quality standards should be calculated. The areal extent of the effect should be estimated.
	1.7.2 Water quality, chemical	Water quality may be impaired.	Acre-feet, %	To the extent possible, the applicant should treat problems of spills and drainage during construction in the same manner as in Item 1.4.1.
1.8 Other impacts				The applicant should describe and quantify any other environmental effects of the proposed station that are significant.
1.9 Combined or interactive effects				Where evidence indicates that the combined effect of a number of impacts on a particular population or resource is not adequately indicated by measures of the separate impacts, the total combined effect should be described.
1.10 Net effects				See discussion in Section 5.7.

TABLE 5 (Page 8 of 16)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
2. GROUND WATER				
2.1 Raising/lowering of ground water levels	2.1.1 People	Availability or quality of drinking water may be decreased, and the functioning of existing wells may be impaired.	Gallons per year	Volume of replacement water for local wells actually affected should be estimated.
	2.1.2 Vegetation	Trees and other deep-rooted vegetation may be affected.	Acres	Estimate the area in which ground water level change may have an adverse effect on local vegetation. Report this acreage on a separate schedule by land use. Specify such uses as recreational, agricultural, and residential.
2.2 Chemical contamination of ground water (excluding salt)	2.2.1 People	Drinking water of nearby communities may be affected.	Gallons per year	Compute annual loss of potable water.
	2.2.2 Vegetation	Trees and other deep-rooted vegetation may experience toxic effects.	Acres	Estimate area affected and report separately by land use. Specify such uses as recreational, agricultural, and residential.
2.3 Radionuclide contamination of ground water	2.3.1 People	Radionuclides that enter ground water may add to natural background radiation level for water and food supplies.	Rem per year for individuals (whole body and organ); man-rem per year for population at the midpoint of station operation	Estimate intakes by individuals and populations. Sum dose contributions for nuclides expected to be released.

TABLE 5 (Page 9 of 16)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
	2.3.2 Vegetation and animals	Radionuclides that enter ground water may add to natural background radiation level for local plant forms and animal population.	Rad per year	Estimate uptake in plants and transfer to animals. Sum dose contributions for nuclides expected to be released.
2.4 Other impacts on ground water				The applicant should describe and quantify any other environmental effects of the proposed station that are significant.
3. AIR				
3.1 Fogging and icing (caused by evaporation and drift)	3.1.1 Ground transportation	Safety hazards may be created in the nearby regions in all seasons.	Vehicle-hours per year	Compute the number of hours per year that driving hazards will be increased on paved highways by fog and ice due to cooling towers and ponds. Documentation should include the visibility criteria used for defining hazardous conditions on the highways actually affected.
	3.1.2 Air transportation	Safety hazards may be created in the nearby regions in all seasons.	Hours per year, flights delayed per year	Compute the number of hours per year that commercial airports will be closed to visual (VFR) and instrumental (IFR) air traffic because of fog and ice from cooling towers. Estimate number of flights delayed per year.
	3.1.3 Water transportation	Safety hazards may be created in the nearby regions in all seasons.	Hours per year, number of ships affected per year	Compute the number of hours per year ships will need to reduce speed because of fog from cooling towers or ponds or because of warm water added to the surface of the river, lake, or sea.

TABLE 5 (Page 10 of 16)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
	3.1.4 Vegetation	Damage to timber and crops may occur through introduction of adverse conditions.	Acres by crop	Estimate the acreage of potential plant damage by crop.
3.2 Chemical discharge to ambient air	3.2.1 Air quality, chemical	Pollutant emissions may diminish the quality of the local ambient air.	% and pounds or tons	The actual concentration of each pollutant in ppm for maximum daily emission rate should be expressed as a percentage of the applicable emission standard. Report weight for expected annual emissions.
	3.2.2 Air quality, odor	Odor in gaseous discharge or from effects on water body may be objectionable.	Statement	A statement must be made as to whether odor originating in station is perceptible at any point offsite.
3.3 Radionuclides discharged to ambient air and direct radiation from radioactive materials (in plant or being transported)	3.3.1 People, external	Radionuclide discharge or direct radiation may add to natural background radiation level.	Rem per year for individuals (whole body and organ); man-rem per year for population at the midpoint of station operation	Sum dose contributions from nuclides expected to be released.
	3.3.2 People, ingestion	Radionuclide discharge may add to the natural radioactivity in vegetation and in soil.	Rem per year for individuals (whole body and organ); man-rem per year for population at the midpoint of station operation	For radionuclides expected to be released, estimate deposit and accumulation in foods. Estimate intakes by individuals and populations and sum results for all expected radionuclides.
	3.3.3 Vegetation and animals	Radionuclide discharge may add to natural background radioactivity of local plant and animal life.	Rad per year	Estimate deposit of radionuclides on and uptake in plants and animals. Sum dose contributions for radionuclides expected to be released.

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
3.4 Other impacts on air				The applicant should describe and quantify any other environmental effects of the proposed plant that are significant.
4. LAND				
4.1 Site selection	4.1.1 Land, amount	Land will be preempted for construction of nuclear power station, station facilities, and exclusion zone.	Acres	State the number of acres preempted for station, exclusion zone, and accessory facilities such as cooling towers and ponds. By separate schedule, state the type and class of land preempted (e.g., scenic shoreline, wet land, forest land, etc.).
4.2 Construction activities (including site preparation)	4.2.1 People (amenities)	There will be a loss of desirable qualities in the environment due to the noise and movement of men, material, and machines.	Total population affected, years	The disruption of community life (or alternatively the degree of community isolation from such irritations) should be estimated. Estimate the number of residences, schools, hospitals, etc., within area of visual and audio impacts. Estimate the duration of impacts and total population affected.
	4.2.2 People (accessibility of historical sites)	Historical sites may be affected by construction	Visitors per year	Determine historical sites that might be displaced by generation facilities. Estimate effect on any other sites in plant environs. Express net impact in terms of annual number of visitors.

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
	4.2.3 People (accessibility of archeological sites)	Construction activity may impinge upon sites of archeological value.	Qualified opinion	Summarize evaluation of impact on archeological resources in terms of remaining potential value of the site. Referenced documentation should include statements from responsible county, State, or Federal agencies, if available.
	4.2.4 Wildlife	Wildlife may be affected.	Qualified opinion	Summarize qualified opinion including views of cognizant local and State wildlife agencies when available, taking into account both beneficial and adverse effects.
	4.2.5 Land (erosion)	Site preparation and station construction will involve cut and fill operations with accompanying erosion potential.	Cubic yards and acres	Estimate soil displaced by construction activity and erosion. Beneficial and detrimental effects should be reported separately.
4.3 Station operation	4.3.1 People (amenities)	Noise may induce stress.	Number of residents, school populations, hospital beds	Use applicable State and local codes for offsite noise levels for assessing impact. If there is no code, consider nearby land use, current zoning, and ambient sound levels in assessing impact. The predicted sound level may be compared with the published guidelines of the Environmental Protection Agency (EPA), American Industrial Hygiene Association, and the Department of Housing and Urban Development (HUD).

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
	4.3.2 People (esthetics)	The local landscape as viewed from adjacent residential areas and neighboring historical, scenic, and recreational sites may be rendered esthetically objectionable by station structures.	Qualified opinion	Summarize qualified opinion, including views of cognizant local and regional authorities when available.
	4.3.3 Wildlife	Wildlife may be affected.	Qualified opinion	Summarize qualified opinion, including views of cognizant local and State wildlife agencies when available, taking into account both beneficial and adverse effects.
	4.3.4 Land, flood control	Health and safety near the water body may be affected by flood control.	Reference to Flood Control District approval	Reference should be made to regulations of cognizant Flood Control Agency by use of one of the following terms: Has *No Implications* for flood control, *Complies* with flood control regulation.
4.4 Salts discharged from cooling towers	4.4.1 People	Intrusion of salts into ground water may affect water supply.	Pounds per square foot per year	Estimate the amount of salts discharged as drift and particulates. Report maximum deposition. Supporting documentation should include patterns of deposition and projection of possible effect on water supplies.

TABLE 5 (Page 14 of 16)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
	4.4.2 Vegetation and animals	Deposition of entrained salts may be detrimental in some nearby regions.	Acres	Salt tolerance of vegetation in affected area must be determined. That area, if any, receiving salt deposition in excess of tolerance (after allowance for dilution) must be estimated. Report separately an appropriate tabulation of acreage by land use. Specify such uses as recreational, agricultural, and residential. Where wildlife habitat is affected, identify populations.
	4.4.3 Property resources	Structures and movable property may suffer degradation from corrosive effects.	Dollars per year	If salt spray impinges upon a local community, property damage may be estimated by applying to the local value of buildings, machinery, and vehicles a differential in average depreciation rates between this and a comparable seacoast community.
4.5 Transmission route selection	4.5.1 Land, amount	Land will be preempted for construction of transmission line systems.	Miles, acres	State total length and area of new rights-of-way. Estimate current market value of land involved.
	4.5.2 Land use and land value	Lines may pass through visually sensitive (that is, sensitive to presence of transmission lines and towers) areas, thus impinging on the present and potential use and value of neighboring property.	Miles, acres, dollars	Total length of new transmission lines and area of rights-of-way through various categories of visually sensitive land. Estimate minimum loss in current property values of adjacent areas.

TABLE 5 (Page 15 of 16)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
	4.5.3 People (esthetics)	Lines may present visually undesirable features.	Number of such features	Estimate total number of visually undesirable features, such as number of major road crossings in vicinity of intersection of interchanges; number of major waterway crossings; number of crest, ridge, or other high point crossings; and number of "long views" of transmission lines perpendicular to highways and waterways.
4.6 Transmission facilities construction	4.6.1 Land adjacent to rights-of-way	Constructing new roads for access to rights-of-way may have environmental impact.	Miles	Estimate length of new access and service roads required for alternative routes.
	4.6.2 Land, erosion	Soil erosion may result from construction activities.	Tons per year	Estimate area with increased erosion potential traceable to construction activities.
	4.6.3 Wildlife	Wildlife habitat and access to habitat may be affected.	Number of important species affected	Identify important species that may be disturbed (Section 2.2).
	4.6.4 Vegetation	Vegetation may be affected.		
4.7 Transmission line operation	4.7.1 Land use	Land preempted by rights-of-way may be used for additional beneficial purposes such as orchards, picnic areas, nurseries, and hiking and riding trails.	%, dollars	Estimate percent of rights-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.

TABLE 5 (Page 16 of 16)

Primary Impact	Population or Resources Affected	Description	Unit of Measure[a]	Method of Computation
4.8 Other land impacts				The applicant should describe and quantify any other environmental effects of the proposed station that 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.

APPENDICES

APPENDIX A

§51.20, 10 CFR PART 51, "APPLICANT'S ENVIRONMENTAL REPORT—CONSTRUCTION PERMIT STAGE"

(a) Environmental considerations. Each applicant[1] 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.

(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[2]). 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 the following table. 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 the number of copies, as specified in § 51.40, of the Environmental Report required by § 51.5(a).

[1] 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.

[2] 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.

TABLE S-3.—Summary of environmental considerations for uranium fuel cycle

[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):[1]		
SO_x	4,400	
NO_x[2]	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^-	.72	Principally from UF_6 production enrichment and reprocessing. Concentration within range of state standards—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: NH_3—600 cfs. NO_3—20 cfs. Fluoride—70 cfs.
NO_3^-	26.7	
Fluoride	12.9	
Ca^{++}	5.4	
Cl^-	8.6	
Na^+	16.9	
NH_3	11.5	
Fe	.4	
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	.02	
Th-230	.02	
Uranium	.032	
Tritium (thousand)	16.7	Principally from fuel reprocessing plants—Whole body dose is 6 man-rem per annual fuel requirements for population within 50 mi radius. This is <0.007 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	.0024 •	
I-131	.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	.0034	From UF_6 production-concentration 5 percent of 10 CFR 20 for total processing of 27.5 model LWR annual fuel requirements.
Th-230	.0015	
Th-234	.01	From fuel fabrication plants—concentration 10 percent of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Ru106[3]	.15	From reprocessing plants—maximum concentration 4 percent of 10 CFR 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.
• Effluents-thermal (billions of British thermal units).	3,360	<7 percent of model 1,000 MWe LWR.
Transportation (man-rem): Exposure of workers and general public.	.334	

[1] Estimated effluents based upon combustion of equivalent coal for power generation.
[2] 1.2 percent from natural gas use and process.
[3] Cs-137 (0.075 Ci/AFR) and Sr-90 (0.004 Ci/AFR) are also emitted.

•Amended 40 FR 31593.

(g)(1) The Environmental Report required by paragraph (a) for light-water cooled nuclear power reactors shall contain either (i) a statement that the transportation of cold fuel to the reactor and irradiated fuel from the reactor to a fuel reprocessing plant and the transportation of solid radioactive wastes from the reactor to waste burial grounds is within the scope of this paragraph, and as the contribution of the environmental effects of such transportation to the environmental costs of licensing the nuclear power reactor, the values set forth in the following Summary Table S-4; or (ii) if such transportation does not fall within the scope of this paragraph, a full description and detailed analysis of the environmental effects of such transportation and, as the contribution of such effects to the environmental costs of licensing the nuclear power reactor, the values determined by such analyses for the environmental impact under normal conditions of transport and the environmental risk from accidents in transport.

(2) This paragraph applies to the transportation of fuel and wastes to and from a nuclear power reactor only if:

(i) The reactor is a light-water-cooled nuclear power reactor with a core thermal power level not exceeding 3,800 megawatts;

(ii) The reactor fuel is in the form of sintered uranium dioxide pellets encapsulated in zircaloy rods with a uranium-235 enrichment not exceeding 4% by weight;

(iii) The average level of irradiation of the irradiated fuel from the reactor does not exceed 33,000 megawatt days per metric ton and no irradiated fuel assembly is shipped until at least 90 days have elapsed after the fuel assembly was discharged from the reactor;

(iv) Waste (other than irradiated fuel) shipped from the reactor is in the form of packaged, solid wastes; and

(v) Unirradiated fuel is shipped to the reactor by truck; irradiated fuel is shipped from the reactor by truck, rail, or barge; and waste other than irradiated fuel is shipped from the reactor by truck or rail.

(3) This paragraph does not apply to any applicant's environmental report submitted prior to February 5, 1975.

SUMMARY TABLE S-4.—*Environmental impact of transportation of fuel and waste to and from 1 light-water-cooled nuclear power reactor* [1]

[Normal conditions of transport]

	Environmental impact
Heat (per irradiated fuel cask in transit)	250,000 Btu/hr.
Weight (governed by Federal or State restrictions)	73,000 lbs. per truck; 100 tons per cask per rail car.
Traffic density:	
Truck	Less than 1 per day.
Rail	Less than 3 per month.

Exposed population	Estimated number of persons exposed	Range of doses to exposed individuals [2] (per reactor year)	Cumulative dose to exposed population (per reactor year)[3]
Transportation workers	200	0.01 to 300 mrem	4 man-rem.
General public:			
Onlookers	1,100	0.003 to 1.3 millirem	3 man-rem.
Along Route	600,000	0.0001 to 0.06 millirem	

ACCIDENTS IN TRANSPORT

	Environmental risk
Radiological effects	Small [4].
Common (nonradiological) causes	1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year.

[1] Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972, and Supp. 1, NUREG-75/038, April 1975. Both documents are available for inspection and copying at the Commission's Public Document Room, 1717 H St. NW., Washington, D.C., and may be obtained from National Technical Information Service, Springfield, Va. 22161. WASH-1238 is available from NTIS at a cost of $5.45 (microfiche, $2.25) and NUREG-75/038 is available at a cost of $3.25 (microfiche, $2.25).

[2] The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.

[3] Man-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem dose in each case would be 1 man-rem.

[4] Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multireactor site.

APPENDIX B

§51.21, 10 CFR PART 51, "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 the number of copies, as specified in § 51.40, 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.

*Amended 41 FR 15832.

APPENDIX C

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

2. Site and resource interface summaries
   2.1 Geography and demography
   2.2 Ecology
   2.3 Meteorology and climatology
   2.4 Hydrology
   2.5 Geology
   2.6 Esthetic and cultural data

3. Station and unit data summaries
   3.1 Building 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. Preoperational program summary

8. Socioeconomic data summary

9. Cost-benefit summary

10. Design alternatives summary

12. Permit and certification summary

13. Reference list

APPENDIX D

USE OF U.S. AGE GROUP POPULATION DISTRIBUTION DATA

The distribution by age of the U. S. population may be used provided there is no knowledge that the area within a radius of 50 miles of the site has a significantly different distribution. The test of significance is to be made by a determination of whether the age distribution in the county in which the proposed station is to be located varied more than 10 percent from the U. S. population in the 1970 decennial census. If this occurred for any of the three age groups, a refinement of the U. S. age group distribution should be made as described below.

The Bureau of Economic Analysis (BEA), U. S. Department of Commerce, has unpublished data on age distribution for 157 BEA regions covering the U.S. These data were compiled for the Office of Business Economics, Department of Commerce and Economic Research Service (OBERS), Department of Agriculture, projections. The age groups are 0 to 14 years, 15 to 64 years, and over 64 years. These data may be obtained without charge by request to the U.S. Department of Commerce.[1]

In employing the OBERS regional forecasts, the ratio-trend method may be used for the disparate class intervals of the age groups. First, select the BEA region containing the county in which the proposed station is to be located. Obtain the age distribution of the region from the above reference. The 0 to 11-year age group population for the BEA area at the midyear of the assumed 30-year operating life of the proposed station can be considered to be 80% of the 0 to 14-year age group since the former was 77% of the latter as of July 1, 1974, and is forecasted at 79% by July 1, 2000. The 12- to 18-year age group requires a different approach. The procedure that should be used makes use of existing forecasts to estimate this age group for the area surrounding the site. It assumes that dependent age groups, i.e., 0 to 18 years, are in about the same proportion for various areas since they generally migrate with their parents. Moreover, this procedure takes advantage of the tendency of birth rate changes across regions to follow similar patterns of changes with different lead-lag relations. The forecasts to be used are for the year of the midpoint of the station operating life. Specific year figures can be obtained by interpolation or extrapolation from the years that are available. The percent of the BEA region population forecasted to be in the 12- to 18-year age group should be found from the following equation:

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

where

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

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

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

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

A is then used to estimate the number of persons in that age group for the area within 50 miles of the proposed site by multiplying the percentage distribution calculated from the above equation by the total population projected for this local area. The population of the 19-years-and-over age group can be obtained by subtracting the sum of the 0 to 11-year and 12- to 18-year age groups from the projected total population of the local area.

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

APPENDIX E

DATA NEEDED FOR RADIOACTIVE SOURCE TERM CALCULATIONS FOR PRESSURIZED WATER REACTORS

The applicant should provide the information listed in this appendix. The information should be consistent with the contents of the safety analysis report (SAR) and the environmental report (ER) of the proposed pressurized water reactor (PWR). Appropriate sections of the SAR and ER containing more detailed discussions or backup data for the required information should be referenced following each response. Each response, however, should be independent of the ER and SAR.[1] This information constitutes the basic data required to calculate the releases of radioactive material in liquid and gaseous effluents (the source terms). All responses should be on a *per-reactor* basis. Indicate systems shared between reactors.

The following data should be provided in Appendix E:

I. *General*

1. 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.)*

2. Core properties:

a. The total mass (lb) of uranium and plutonium in an equilibrium core (metal weight),

b. The percent enrichment of uranium in reload fuel, and

c. The percent of fissile plutonium in reload fuel.

3. If methods and parameters used in estimating the source terms in the primary coolant are different from those given in Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," describe in detail the methods and parameters used. Include the following information:

a. Station capacity factor,

b. Fraction of fuel releasing radioactivity in the primary coolant (indicate the type of fuel cladding),

c. Concentration of fission, activation, and corrosion products in the primary and secondary coolant (μCi/g). Provide the bases for the values used.

4. The quantity of tritium released in liquid and gaseous effluents (Ci/yr per reactor).

II. *Primary System*

1. The total mass (lb) of coolant in the primary system, excluding the pressurizer and primary coolant purification system at full power.

2. The average primary system letdown rate (gpm) to the primary coolant purification system.

3. 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.)

4. The average shim bleed flow (gpm).

III. *Secondary System*

1. The number and type of steam generators and the carryover factor used in the applicant's evaluation for iodine and nonvolatiles.

2. The total steam flow (lb/hr) in the secondary system.

3. The mass of steam in each steam generator (lb) at full power.

4. The mass of liquid in each steam generator (lb) at full power.

5. The total mass of coolant in the secondary system (lb) at full power. For recirculating U-tube steam generators, do not include the coolant in the condenser hotwell.

6. The primary to secondary system leakage rate (lb/day) used in the evaluation.

7. Description of the steam generator blowdown and blowdown purification systems. The average steam generator blowdown rate (lb/hr) used in the applicant's evaluation. The parameters used for steam generator blowdown rate (lb/hr).

8. The fraction of the steam generator feedwater processed through the condensate demineralizers and the

[1] The ER or SAR may be referenced as to the bases for the parameters used; however, the parameters should be given with the responses in this appendix.

decontamination factors (DF) used in the evaluation for the condensate demineralizer system.

9. Condensate demineralizers:

a. Average flow rate (lb/hr),

b. Demineralizer type (deep bed or powdered resin),

c. Number and size (ft^3) of demineralizers,

d. Regeneration frequency,

e. Indicate whether ultrasonic resin cleaning is used and the waste liquid volume associated with its use, and

f. Regenerant volume (gal/event) and activity.

IV. *Liquid Waste Processing Systems*

1. For each liquid waste processing system (including the shim bleed, steam generator blowdown, and detergent waste processing systems), provide in tabular form the following information:

a. Sources, flow rates (gpd), and expected activities (fraction of primary coolant activity, PCA) for all inputs to each system,

b. Holdup times associated with collection, processing, and discharge of all liquid streams,

c. Capacities of all tanks (gal) and processing equipment (gpd) considered in calculating holdup times,

d. Decontamination factors for each processing step,

e. Fraction of each processing stream expected to be discharged over the life of the station,

f. For demineralizer regeneration provide: time between regenerations, regenerant volumes and activities, treatment of regenerants, and fraction of regenerant discharged (include parameters used in making these determinations), and

g. Liquid source term by radionuclide in Ci/yr for normal operation, including anticipated operational occurrences.

2. Piping and instrumentation diagrams (P&IDs) and process flow diagrams for the liquid radwaste systems along with all other systems influencing the source term calculations.

V. *Gaseous Waste Processing System*

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

2. Description of the process used to hold up gases stripped from the primary system during normal operations and reactor shutdown. If pressurized storage tanks are used, include a process flow diagram of the system indicating the capacities (ft^3), number, and design and operating storage pressures for the storage tanks.

3. Description of the normal operation of the system, e.g., number of tanks held in reserve for back-to-back shutdown, fill time for tanks. Indicate the minimum holdup time used in the applicant's evaluation and the basis for this number.

4. If HEPA filters are used downstream of the pressurized storage tanks, provide the decontamination factor used in the evaluation.

5. If a charcoal delay system is used, describe this system and indicate the minimum holdup times for each radionuclide considered in the evaluation. List all parameters, including mass of charcoal (lb), flow rate (cfm), operating and dew point temperatures, and dynamic adsorption coefficients for Xe and Kr used in calculating holdup times.

6. Piping and instrumentation diagrams (P&IDs) and process flow diagrams for the gaseous radwaste systems, along with other systems influencing the source term calculations.

VI. *Ventilation and Exhaust Systems*

For each building housing systems that contain radioactive materials, the steam generator blowdown system vent exhaust, and the main condenser air removal system, provide the following:

1. Provisions incorporated to reduce radioactivity releases through the ventilation or exhaust systems.

2. Decontamination factors assumed and the bases (include charcoal adsorbers, HEPA filters, mechanical devices).

3. Release rates for radioiodine, noble gases, and radioactive particulates (Ci/yr), and the bases.

4. Release points to the environment, including height, effluent temperature, and exit velocity.

5. For the containment building, provide the building free volume (ft^3) and a thorough description of the internal recirculation system (if provided), including

the recirculation rate, charcoal bed depth, operating time assumed, and mixing efficiency. Indicate the expected purge and venting frequencies and duration and continuous purge rate (if used).

VII. *Solid Waste Processing Systems*

1. In tabular form, provide the following information concerning all inputs to the solid waste processing system: source, volume (ft^3/yr per reactor), and activity (Ci/yr per reactor) of principal radionuclides, along with bases for values used.

2. Provide information on onsite storage provisions (location and capacity) and expected onsite storage times for all solid wastes prior to shipment.

3. Provide piping and instrumentation diagrams (P&IDs) for the solid radwaste system.

APPENDIX F

DATA NEEDED FOR RADIOACTIVE SOURCE TERM CALCULATIONS FOR BOILING WATER REACTORS

The applicant should provide the information listed in this appendix. The information should be consistent with the contents of the safety analysis report (SAR) and the environmental report (ER) of the proposed boiling water reactor (BWR). Appropriate sections of the SAR and ER containing more detailed discussions of the required information should be referenced following each response. Each response, however, should be independent of the ER and SAR.[1] This information constitutes the basic data required to calculate the releases of radioactive material in liquid and gaseous effluents (the source terms). All responses should be on a *per-reactor* basis. Indicate systems shared between reactors.

The following data should be provided in Appendix F:

I. *General*

1. 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.)*

2. Core properties:

a. The total mass (lb) of uranium and plutonium in an equilibrium core (metal weight),

b. The percent enrichment of uranium in reload fuel, and

c. The percent of fissile plutonium in reload fuel.

3. If methods and parameters used in estimating the source terms in the primary coolant are different from those given in Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors," describe in detail the methods and parameters used. Include the following information:

a. Plant capacity factor,

b. Isotopic release rates of noble gases to the reactor coolant at 30-minute decay (μCi/sec), and

c. Concentration of fission, corrosion, and activation products in the reactor coolant (μCi/sec). Provide the bases for the values used.

4. The quantity of tritium released in liquid and gaseous effluents (Ci/yr per reactor).

II. *Nuclear Steam Supply System*

1. Total steam flow rate (lb/hr).

2. Mass of reactor coolant (lb) and steam (lb) in the reactor vessel at full power.

III. *Reactor Coolant Cleanup System*

1. Average flow rate (lb/hr).

2. Demineralizer type (deep bed or powdered resin).

3. Regeneration frequency.

4. Regenerant volume (gal/event) and activity.

IV. *Condensate Demineralizers*

1. Average flow rate (lb/hr).

2. Demineralizer type (deep bed or powdered resin).

3. Number and size (ft^3) of demineralizers.

4. Regeneration frequency.

5. Indicate whether ultrasonic resin cleaning is used and the waste liquid volume associated with its use.

6. Regenerant volume (gal/event) and activity.

V. *Liquid Waste Processing Systems*

1. For each liquid waste processing system, provide in tabular form the following information:

a. Sources, flow rates (gpd), and expected activities (fraction of primary coolant activity, PCA) for all inputs to each system,

b. Holdup times associated with collection, processing, and discharge of all liquid streams,

c. Capacities of all tanks (gal) and processing equipment (gpd) considered in calculating holdup times,

[1]The ER or SAR may be referenced as to the bases for the parameters used; however, the parameters should be given with the responses in this appendix.

d. Decontamination factors for each processing step,

e. Fraction of each processing stream expected to be discharged over the life of the station,

f. For waste demineralizer regeneration, time between regenerations, regenerant volumes and activities, treatment of regenerants, and fractions of regenerant discharged (include parameters used in making these determinations), and

g. Liquid source term by radionuclide in Ci/yr for normal operation, including anticipated operational occurrences.

2. Piping and instrumentation diagrams (P&IDs) and process flow diagrams for the liquid radwaste systems along with all other systems influencing the source term calculations.

VI. *Main Condenser and Turbine Gland Seal Air Removal Systems*

1. The holdup time (hr) for offgases from the main condenser air ejector prior to processing by the offgas treatment system.

2. Description and expected performance of the gaseous waste treatment systems for the offgases from the condenser air ejector and mechanical vacuum pump. The expected air inleakage per condenser shell, the number of condenser shells, and the iodine source term from the condenser.

3. The mass of charcoal (tons) in the charcoal delay system used to treat the offgases from the main condenser air ejector, the operating and dew point temperatures of the delay system, and the dynamic adsorption coefficients for Xe and Kr.

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

5. The steam flow (lb/hr) to the turbine gland seal and the source of the steam (primary or auxiliary).

6. The design holdup time (hr) for gas vented from the gland seal condenser, the iodine partition factor for the condenser, and the fraction of radioiodine released through the system vent. Description of the treatment system used to reduce radioiodine and particulate releases from the gland seal system.

7. Piping and instrumentation diagrams (P&IDs) and process flow diagrams for the gaseous waste treatment system along with all other systems influencing the source term calculations.

VII. *Ventilation and Exhaust Systems*

For each station building housing system that contains radioactive materials, provide the following:

1. Provisions incorporated to reduce radioactivity releases through the ventilation or exhaust systems.

2. Decontamination factors assumed and the bases (include charcoal adsorbers, HEPA filters, mechanical devices).

3. Release rates for radioiodines, noble gases, and radioactive particulates (Ci/yr) and the bases.

4. Release point to the environment including height, effluent temperature, and exit velocity.

5. For the containment building, indicate the expected purge and venting frequencies and duration, and continuous purge rate (if used).

VIII. *Solid Waste Processing Systems*

1. In tabular form, provide the following information concerning all inputs to the solid waste processing system: source, volume (ft^3/yr per reactor), and activity (Ci/yr per reactor) of principal radionuclides along with bases for values.

2. Onsite storage provisions (location and capacity) and expected onsite storage times for all solid wastes prior to shipment.

3. Piping and instrumentation diagrams (P&IDs) and process flow diagrams for the solid radwaste system.

APPENDIX G

DATA NEEDED FOR RADWASTE TREATMENT SYSTEM COST-BENEFIT ANALYSIS FOR LIGHT-WATER-COOLED NUCLEAR REACTORS

The applicant should provide the information listed in Tables G.1 and G.2. The information should be consistent with the contents of the safety analysis report (SAR) and environmental report (ER) for the proposed reactor. Appropriate sections of the SAR and ER containing more detailed discussions of the required information should be referenced following each response. Each response, however, should be independent of the ER and SAR. This information constitutes the basic data required in performing a cost-benefit analysis for radwaste treatment systems. All responses should be on a *per-reactor* basis. The following information should be provided:

1. Detailed cost estimate sheets, similar to Tables G.1 and G.2, listing all paremeters (and their bases) used in determining capital, operating, and maintenance costs associated with all augments considered in the cost-benefit analysis. All costs should be stated in terms of 1975 dollars.

2. The cost of borrowed money used in the cost analysis and the method of arriving at this cost.

3. If methods and parameters used in the cost-benefit analysis are different from those given in Regulatory Guide 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors," describe in detail the methods used and provide the bases for all parameters. Include the following information:

a. Decontamination factors assigned to each augment and fraction of "online" time assumed, i.e., hours per year used.

b. Parameters and method used to determine the Indirect Cost Factor and the Capital Recovery Factor.

TABLE G.1

TOTAL DIRECT COST ESTIMATE SHEET
OF RADWASTE TREATMENT SYSTEM
FOR LIGHT-WATER-COOLED NUCLEAR REACTORS

Description of Augment ________________________________

DIRECT COST (1975 $1000)/REACTOR

ITEM	LABOR	EQUIPMENT/MATERIALS	TOTAL	BASIS FOR COST ESTIMATE
1. PROCESS EQUIPMENT				
2. BUILDING ASSIGNMENT				
3. ASSOCIATED PIPING SYSTEMS				
4. INSTRUMENTATION AND CONTROLS				
5. ELECTRICAL SERVICE				
6. SPARE PARTS				
SUB TOTAL				
7. CONTINGENCY				
8. TOTAL DIRECT COSTS				

TABLE G.2

ANNUAL OPERATING AND MAINTENANCE COST ESTIMATE SHEET FOR RADWASTE TREATMENT SYSTEM FOR LIGHT-WATER-COOLED NUCLEAR REACTORS

Description of Augment ______________________________

COST (1975 $1000)/REACTOR

ITEM	LABOR	OTHER	TOTAL	BASIS FOR COST ESTIMATE
1. OPERATING LABOR, SUPERVISORY AND OVERHEAD				
2. MAINTENANCE MATERIAL AND LABOR				
3. CONSUMABLES, CHEMICALS, AND SUPPLIES				
4. UTILITIES AND SERVICES Waste Disposal Water Steam Electricity Building Services Other				
5. TOTAL OPERATING AND MAINTENANCE ANNUAL COST				

APPENDIX H

EXAMPLES OF FIGURES SHOWING RADIATION EXPOSURE PATHWAYS

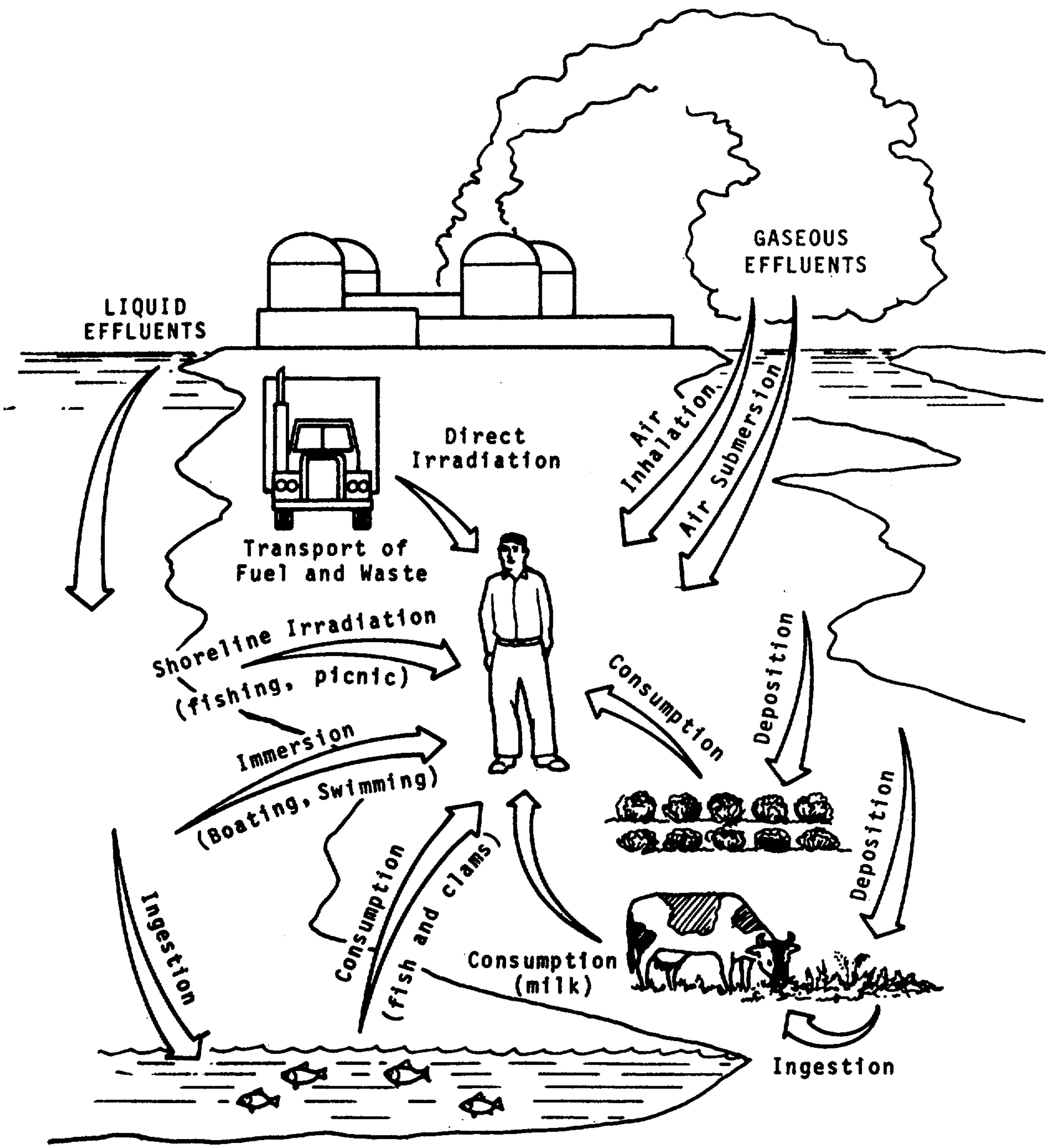

Figure H-1. Generalized Exposure Pathways for Man

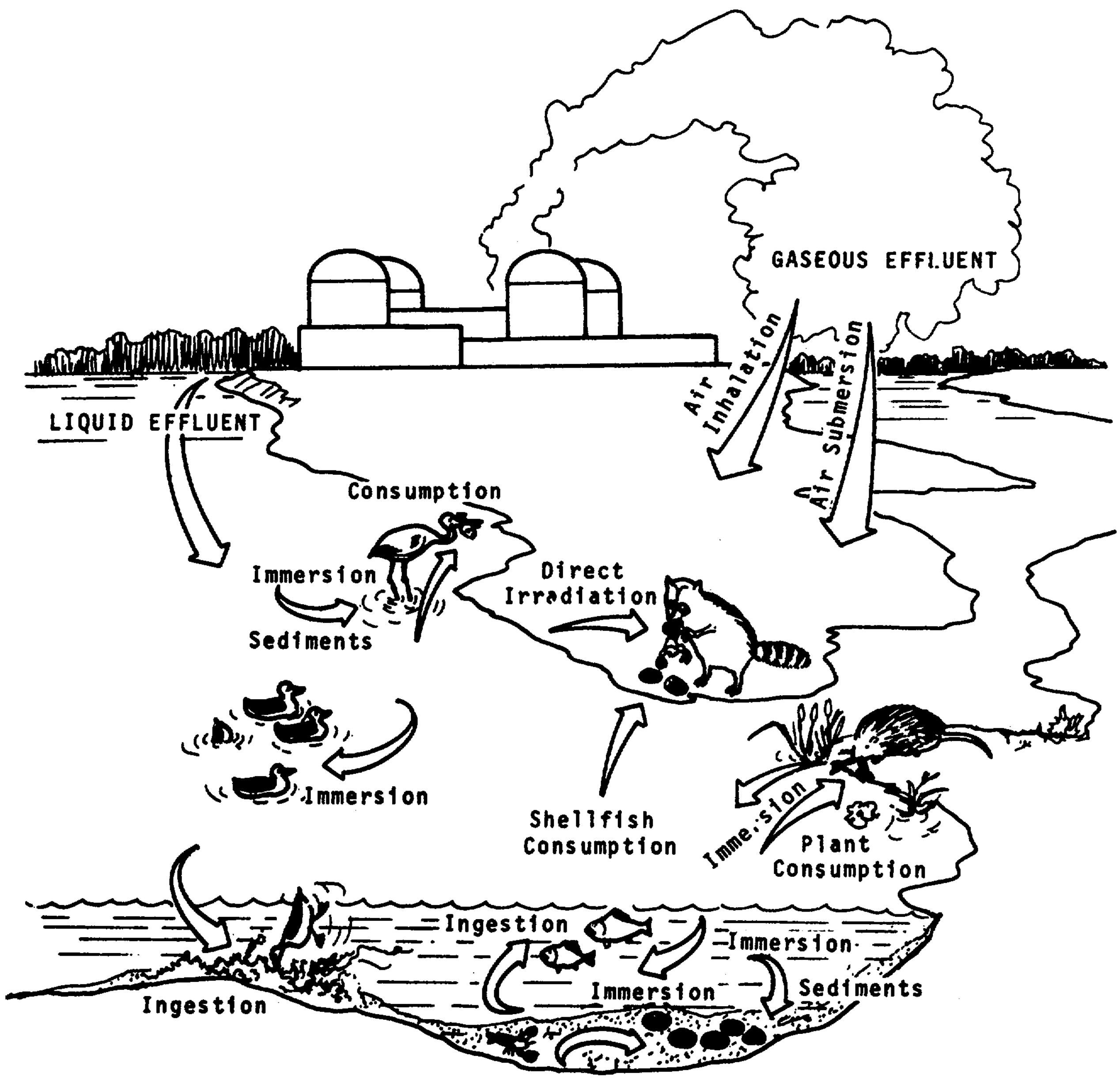

Figure H-2. Generalized Exposure Pathways for Organisms Other Than Man

APPENDIX I
PROPOSED ANNEX TO APPENDIX D, 10 CFR PART 50

DISCUSSION OF ACCIDENTS IN APPLICANTS' ENVIRONMENTAL REPORTS: ASSUMPTIONS

The complete text of the proposed Annex to Appendix D, 10 CFR Part 50, follows. It was originally published in the Federal Register *December 1, 1971 (36 FR 22851).*

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.

[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.

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.

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

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.

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[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. Nuclear Regulatory Commission, Washington, D.C. 20555. (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. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Director of Office of Standards Development.)

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.

(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 ft²)

(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.

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