



DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE DG-4026

(Proposed Revision 3 to Regulatory Guide 4.2, dated July 1976)

PREPARATION OF ENVIRONMENTAL REPORTS FOR NUCLEAR POWER STATIONS

A. INTRODUCTION

Purpose

This regulatory guide (RG) provides guidance to applicants for format and content of environmental reports (ERs) that are submitted as part of an application for a permit, license, or other authorization to site, construct, and/or operate a new nuclear power plant.

Applicability

This RG applies to applicants for a permit, license, or other approval for a nuclear power plant subject to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, “Domestic Licensing of Production and Utilization Facilities” (Ref. 1), 10 CFR Part 52 “Licenses, Certifications, and Approvals for Nuclear Power Plants” (Ref. 2), and the associated review under 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions” (Ref. 3).

Applicable Regulations

- The National Environmental Policy Act of 1969, as amended (NEPA; 42 United States Code (U.S.C.) 4321 et seq.) (Ref. 4), implemented by Executive Orders (EO) 11514 “Protection and Enhancement of Environmental Quality” (Ref. 5), and 11991 “Environmental Impact Statements” (Ref. 6), and the Council on Environmental Quality’s regulations at 40 CFR Chapter V – Council on Environmental Quality - Index to Parts 1500–1508 (Ref. 7), require that all agencies of the Federal Government prepare detailed environmental impact statements on proposed major Federal actions that will significantly affect the quality of the human environment. A principal objective of NEPA is to require the Federal agency to consider, in its decision-making process,

This regulatory guide is being issued in draft form to involve the public in the development of regulatory guidance in this area. It has not received final staff review or approval and does not represent an NRC final staff position. Public comments are being solicited on this draft guide and its associated regulatory analysis. Comments should be accompanied by appropriate supporting data. Comments may be submitted through the Federal-rulemaking Web site, <http://www.regulations.gov>, by searching for Docket ID **INSERT**: NRC-2017-0041. Alternatively, comments may be submitted to the Rules, Announcements, and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments must be submitted by the date indicated in the *Federal Register* notice.

Electronic copies of this draft regulatory guide, previous versions of this guide, and other recently issued guides are available through the NRC’s public Web site under the Regulatory Guides document collection of the NRC Library at <http://www.nrc.gov/reading-rm/doc-collections/reg-guides/>. The draft regulatory guide is also available through the NRC’s Agencywide Documents Access and Management System (ADAMS) at <http://www.nrc.gov/reading-rm/adams.html>, under Accession No. ML16116A068. The regulatory analysis may be found in ADAMS under Accession No. ML16116A067.

the environmental impacts of each proposed major Federal action and the available alternative actions, including alternative sites.

- 10 CFR Part 50 governs the licensing of nuclear power plants. Certain sections in 10 CFR Part 50 provide requirements for submittal of ERs in support applications for early site permits (ESPs), combined licenses (COLs), limited work authorizations (LWAs), construction permits (CPs), and operating licenses (OLs).
- 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” provides requirements for U.S. Nuclear Regulatory Commission’s (NRC’s) preparation and processing of environmental impact statements (EIS) and related documents under Section 102(2)(C) of NEPA. In 10 CFR 51.45, the NRC sets forth the general requirements for an ER. Specific requirements governing ERs for production and utilization facilities are set forth in 10 CFR 51.49 to 51.58.
- 10 CFR Part 52 governs the issuance of ESPs, design certifications (DCs), COLs, standard design approvals, and manufacturing licenses for nuclear power facilities licensed under Section 103 of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2133) (Ref. 8), and Title II of the Energy Reorganization Act of 1974 (42 U.S.C. 5841-5853) (Ref. 9). Certain sections in 10 CFR Part 52 describe requirements for inclusion of ERs for ESPs, DCs, COLs, standard design approvals, and manufacturing licenses.

Related Guidance

- RG 1.206, “Combined License Application for Nuclear Power Plants (LWR Edition)” (Ref. 10), identifies sources of information that can be used by applicants in the development of ERs for COL applications.
- RG 4.7, “General Site Suitability Criteria for Nuclear Power Stations” (Ref. 11), discusses the major site characteristics related to public health and safety and environmental issues that the NRC staff considers in determining the suitability of sites for light-water-cooled nuclear power stations.
- RG 4.11, “Terrestrial Environmental Studies for Nuclear Power Stations” (Ref. 12), provides technical guidance that the NRC staff considers acceptable for terrestrial environmental studies and analyses supporting licensing decisions for nuclear power reactors.
- NUREG-1555, “Environmental Standard Review Plan: Standard Review Plans for Environmental Reviews for Nuclear Power Plants” (Ref. 13), provides the criteria used by the NRC staff for reviewing ERs submitted with nuclear power plant license applications.

Purpose of Regulatory Guides

The NRC issues RGs to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency’s regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations and compliance with them is not required. Methods and solutions that differ from those set forth in RGs will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

Paperwork Reduction Act

This RG contains and references information collections covered by 10 CFR Parts 50, 51, and 52 that are subject to the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.). These information collections were approved by the Office of Management and Budget (OMB) control numbers 3150-0011, 3150-0021, and 3150-0155.

Public Protection Notification

The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number.

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B. DISCUSSION

Reason for Revision

Regulatory Guide 4.2, Revision 2 dates to 1976, and an update is needed to align guidance with U.S. Nuclear Regulatory Commission (NRC) regulations, interim NRC guidance, changes in environmental statutes and regulations, and Executive Orders. This guide is being updated to provide general guidelines for the preparation of ERs supporting an application for a permit, license, or authorization to site, construct, and/or operate a new nuclear power plant. Permits and licenses for siting, construction, and operation of nuclear power plants include limited work authorizations (LWAs), construction permits (CPs), and operating licenses (OLs) in accordance with 10 CFR Part 50 and early site permits (ESPs), combined licenses (COLs), and design certifications (DCs) in accordance with 10 CFR Part 52. The information requested from applicants in this RG is based on staff guidance such as NUREG-1555 and requirements contained in 10 CFR Part 51.

Background

Since issuance of Revision 2 in 1976, the NRC staff has developed or revised regulations including 10 CFR 51.45 related to the requirements for submitting ERs, and 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants.” Additionally, while preparing environmental impact statements (EISs) for the first group of combined license (COL) applications, the NRC staff identified a number of issues that necessitated changes to staff guidance. In 2014, the NRC staff documented these changes in two interim staff guidance documents, COL/ESP-ISG-026, “Interim Staff Guidance on Environmental Issues Associated with New Reactors” (Ref. 14), and COL/ESP-ISG-027, “Interim Staff Guidance on Specific Environmental Guidance for Light Water Small Modular Reactor Reviews” (Ref. 15), which addressed changes to environmental statutes, regulations, and Executive Orders which directly affect the information required by the NRC to develop EISs. Examples of changes include, but are not limited to, the assessment of building impacts, greenhouse gas and climate change, socioeconomics, environmental justice, need for power, alternatives, and cumulative effects.

Harmonization with International Codes and Standards

The International Atomic Energy Agency (IAEA) has established a series of technical reports and safety guides for protecting people and the environment. These technical reports and safety guides present international good practices to help users striving to achieve high levels of environmental protection and human safety. Similar to this RG, IAEA Nuclear Energy Series No. NG-T-3.11, “Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes” (Ref. 16), addresses the basic concepts of environmental impact assessment and a methodological approach for estimating health and environmental impacts. IAEA Safety Guide NS-R-3, “Site Evaluation for Nuclear Installations” (Ref. 17), contains recommendations for the collection of information to assess the safety and environmental suitability of a site for a nuclear installation. The NRC has an interest in facilitating the harmonization of standards used domestically and internationally. Use of this RG would, in general, be consistent with the principles and basic aspects of environmental impact assessment described in the IAEA Technical Reports Series and Safety Guides on health and environmental impacts and site evaluation.

Documents Discussed in Staff Regulatory Guidance

This RG addresses, in part, the use of one or more codes or standards developed by external organizations, and other third-party guidance documents. These codes, standards and third-party guidance

documents may contain references to other codes, standards or third-party guidance documents (“secondary references”). If a secondary reference has itself been incorporated by reference into NRC regulations as a requirement, then applicants must comply with that standard as set forth in the regulation. If the secondary reference has been endorsed in an RG as an acceptable approach for meeting an NRC requirement, then the standard constitutes a method acceptable to the NRC staff for meeting that regulatory requirement as described in the specific RG. If the secondary reference has neither been incorporated by reference into NRC regulations nor endorsed in an RG, then the secondary reference is neither a legally binding requirement nor a “generic” NRC-approved acceptable approach for meeting an NRC requirement. However, licensees and applicants may consider and use the information in the secondary reference, if appropriately justified, consistent with current regulatory practice, and consistent with applicable NRC requirements.

Abbreviations/Acronyms

| | |
|---------|---|
| ACHP | Advisory Council on Historic Preservation |
| ACS | American Community Survey |
| ADAMS | Agencywide Documents Access and Management System |
| APE | area of potential effect |
| CBG | Census block group |
| CEQ | Council on Environmental Quality |
| CFR | <i>Code of Federal Regulations</i> |
| COL | combined license |
| CP | construction permit |
| CWA | Clean Water Act (aka Federal Water Pollution Control Act) |
| dBA | decibel(s) on the A-weighted scale |
| DBA | design-basis accident |
| DC | design certification |
| DCD | design control document |
| D/Q | atmospheric deposition factor(s) |
| DSM | demand-side management |
| EA | environmental assessment |
| EAB | exclusion area boundary |
| EE | energy efficiency |
| EFH | essential fish habitat |
| EIS | environmental impact statement |
| EJ | environmental justice |
| ELF-EMF | extremely low frequency-electromagnetic field |
| EMF | electromagnetic field |
| EPA | U.S. Environmental Protection Agency |
| ER | environmental report |
| ESA | Endangered Species Act of 1973, as amended |
| ESP | early site permit |
| FR | <i>Federal Register</i> |
| FSAR | final safety analysis report |

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|--------------------|--|
| FWS | U.S. Fish and Wildlife Service |
| gal | gallon(s) |
| GASPAR | gaseous and particulate (code) |
| GEIS | Generic Environmental Impact Statement |
| GHG | greenhouse gas |
| GIS | geographic information system |
| GWP | global warming potential |
| Hz | hertz |
| IAEA | International Atomic Energy Agency |
| ISFSI | independent spent-fuel storage installation |
| ISO | independent system operator |
| kg/ha/mo | kilogram(s)/hectare/month |
| kWh | kilowatt-hour(s) |
| LADTAP | Liquid Annual Dose to All Persons (code) |
| LEDPA | least environmentally damaging practicable alternative |
| LLWR | large light water reactor |
| LPZ | low-population zone |
| LWA | limited work authorization |
| LWR | light water reactor |
| m ³ | cubic meter(s) |
| m ³ /yr | cubic meters per year |
| MACCS | MELCOR Accident Consequence Code System |
| MEI | maximally exposed individual |
| Mgd | million gallon(s) per day |
| mi | mile(s) |
| mrad | millirad |
| mrad/d | millirad/day |
| mrem | millirem |
| mrem/yr | millirem per year |
| MSA | Magnuson–Stevens Fishery Conservation and Management Act of 1996 |

| | |
|---------|---|
| MTU | metric ton uranium |
| MWd/MTU | megawatt-days per metric ton of uranium |
| MW(e) | megawatt(s) electric |
| MW(t) | megawatt(s) thermal |
| MWh | megawatt hour(s) |
| MWh/yr | megawatt hour(s) per year |
| NAAQS | National Ambient Air Quality Standards |
| NCRP | National Council on Radiation Protection and Measurements |
| NEI | Nuclear Energy Institute |
| NEPA | National Environmental Policy Act of 1969, as amended |
| NHPA | National Historic Preservation Act of 1966, as amended |
| NIEHS | National Institute of Environmental Health Sciences |
| NMFS | National Marine Fisheries Service |
| NPDES | National Pollutant Discharge Elimination System |
| NRC | U.S. Nuclear Regulatory Commission |
| NRHP | National Register of Historic Places |
| NUREG | U.S. Nuclear Regulatory Commission technical document |
| NWS | National Weather Service |
| OL | operating license |
| OMB | Office of Management and Budget |
| PPE | plant parameter envelope |
| rem | roentgen equivalent man |
| REMP | radiological environmental monitoring program |
| RG | regulatory guide |
| ROI | region of interest |
| RTO | regional transmission organization |
| SAMA | severe accident mitigation alternative |
| SAMDA | severe accident mitigation design alternative |
| SAR | safety analysis report |
| SHPO | State Historic Preservation Office (or Officer) |
| SMR | small modular reactor |

| | |
|----------|----------------------------------|
| U.S. | United States |
| USACE | U.S. Army Corps of Engineers |
| U.S.C. | United States Code |
| χ/Q | atmospheric dispersion factor(s) |

C. STAFF REGULATORY GUIDANCE

General Guidance to Applicants

I. Summary

This section summarizes general guidance for developing environmental reports (ERs) under 10 CFR Part 51 for applications for licenses, permits, authorizations for new reactors pursuant to 10 CFR Part 50 and 52. The information provided in Part C is applicable to ERs for large light-water reactor combined license (COL) applications not referencing an early site permit (ESP). Appendix A provides supplemental guidance for the development of ERs for other authorizations and licenses that can be granted by the U.S. Nuclear Regulatory Commission (NRC) under 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” and 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” including ESPs, COLs referencing an ESP, construction permits (CPs), operating licenses (OLs), limited work authorizations (LWAs), and standard design certifications (DCs). Appendix B describes the requirements for the NRC to consult with other Federal agencies under other environmental statutes and the information the NRC staff needs to complete those consultations. Appendix C provides additional guidance on the preparation of ERs under 10 CFR 51 for applications for new light-water small modular reactors.

General guidance in this section includes generic definitions, consultations, non-NRC permits and approvals, impact findings, mitigation of adverse impacts, and issues related to the definition of construction at 10 CFR 50.10(a). General guidance related to the presentation of referenced material or other information in the ER sufficient to support the NRC’s development of the EIS is also provided in this section of this RG.

Applicants should be cognizant of the NRC’s current environmental review process and practices through the review of:

- applicable NRC regulations;
- the most recent versions of regulatory guidance related to the appropriate level and scope of environmental studies or information which the Commission may require to be submitted in connection with an application (e.g., RG 4.11);
- recent EISs prepared by NRC staff; and
- NUREG-1555.

In addition, applicants are encouraged to confer with NRC staff as early as possible in the planning process before submitting environmental information or filing an application in accordance with 10 CFR 51.40, “Consultation with NRC staff,” and as discussed in RG 1.206.

The following terminology applies only to the environmental review process and is used as follows in this RG:

- **STATION:** All facilities (e.g., reactors, control buildings, intakes, discharges, etc.) that are located or are proposed to be located on the applicant’s site. Generally, the station includes everything located on the applicant’s property that surrounds the proposed or existing reactors. In some cases, intakes and discharges may be beyond this property line, but are considered part of the station. Transmission lines and their associated facilities beyond the on-site switchyard are not

considered part of the station. Existing or proposed facilities not associated with the production of electricity (e.g., a visitor center) are considered part of the station.

- **PLANT:** The proposed nuclear reactors, reactor power conversion systems, intakes, discharges, and all other on-station facilities involved with the production of electricity. A plant can be more than one reactor power conversion system, but does not include existing units already in operation. Transmission lines and other off-station facilities are not part of the plant.
- **UNIT:** One reactor power conversion system. Generally, unit is used only when the applicant is proposing a multi-unit plant for large light water reactors.
- **FACILITY:** Any identifiable part of the station or associated portions of the applicant's system, both existing and proposed. Examples include:
 - a visitor center
 - a substation
 - an intake system (if separated from the remainder of the plant)
- **PROJECT:** Everything the applicant is proposing. This includes transmission lines, access roads, communications stations, etc.

II. Consultations and Coordinations

The NRC is responsible for conducting consultations under certain Federal laws, as appropriate, such as the Endangered Species Act of 1973 (16 United States Code (U.S.C.) 1531 et seq.) (Ref. 18), the Magnuson-Stevens Fishery Conservation and Management Act of 1996, Section 305 (16 U.S.C. 1855) (Ref. 19), and the National Historic Preservation Act of 1996, as amended (NHPA) (54 U.S.C. 300101 et seq.) (Ref. 20). The information requested in this RG will help the NRC meet its responsibilities to consult with other Federal, State, and Tribal agencies under these Federal laws. The applicant should provide sufficient information in the ER to enable the NRC to complete the consultation processes. Additional information related to consultations is found in Appendix B of this RG.

In addition, there are laws and Executive Orders that may require coordination between the NRC and other Federal and State agencies before granting a license or a permit. One example is the Fish and Wildlife Coordination Act (Ref. 21), enacted in 1934 to ensure that water resource development projects do not conflict with the conservation of fish and wildlife resources. Under the Fish and Wildlife Coordination Act, Federal agencies must consult with the U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), as well as the State agency exercising administration over fish and wildlife resources when any body of water is proposed or authorized to be modified by any public or private agency under a Federal permit or license. Although coordination with other Federal agencies is the responsibility of the NRC, the proponent of the action (the applicant) should provide sufficient information to enable the NRC to complete the coordination process.

III. Non-NRC Permits and Approvals

In many cases, the NRC cannot issue a license or permit until the appropriate State or other Federal agencies have granted licenses or permits to the applicant. Applicants are required to comply with applicable Federal and State environmental statutes. The exact license or permit requirements will be dependent on factors such as water sources, proposed activities, as well as State permitting requirements, which can vary between states. Examples include the following:

- Clean Water Act of 1972 (CWA) (33 U.S.C. 1251 et seq.) (Ref. 22), was enacted to preserve and restore the quality of the Nation's surface waters. Section 401 of the CWA requires that an applicant for a Federal license or permit that may result in a discharge of regulated pollutants into

waters of the United States obtain, and provide to the Federal licensing agency (i.e., the NRC), a Section 401 water-quality certification from the State, interstate agency or authorized Tribe with jurisdiction over the discharge. The NRC cannot issue a license or permit until the appropriate jurisdiction has granted or waived the Section 401 certification. Additionally, the NRC cannot issue a license or permit if certification has been denied by the State, interstate agency, or the Environmental Protection Agency (EPA) Administrator.

- Section 402 of the CWA establishes the National Pollutant Discharge Elimination System (NPDES) permit program to regulate point source discharges of pollutants into waters of the United States. An NPDES permit sets specific discharge limits for point sources discharging pollutants into waters of the United States and establishes monitoring and reporting requirements, as well as special conditions. The EPA is charged with administering the NPDES permit program, but can authorize states to assume many of the permitting, administrative, and enforcement responsibilities of the NPDES permit program. Authorized states are prohibited from adopting standards that are less stringent than those established under the Federal NPDES permit program, but may adopt or enforce standards that are more stringent than the Federal standards if allowed under state law.
- Section 404 of the CWA requires a 404 permit for discharge of dredged or fill material into wetlands and waters of the U.S. The U.S. Army Corps of Engineers (USACE) and the EPA are responsible for administering and enforcing Section 404. States and Tribes can administrate the 404 permit program in certain non-navigable waters that are within their jurisdiction. If the applicant requires a Section 404 permit, then the NRC cannot issue a license unless the authorized agency has either issued the permit or waived the requirement.
- Clean Air Act, Section 176 (42 U.S.C. 7401 et seq.) (Ref. 23), prohibits Federal agencies from undertaking, licensing, permitting, approving, or supporting any action in a maintenance or non-attainment area that does not conform to the applicable State Implementation Plan. The General Conformity Rule requires that Federal agencies demonstrate conformity to the applicable State Implementation Plan. If required, the conformity determination must be completed before the license or permit is issued.
- Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et seq.) (Ref. 24), requires that activities of Federal agencies that are reasonably likely to affect coastal zones be consistent with any applicable State approved Coastal Management Program to the maximum extent practicable. Applicants must submit to both the NRC and to the State a certification that the proposed activity complies with the enforceable policies of the State's program. If the Coastal Zone Management Act applies to the project, the NRC cannot issue its license or permit until the State has concurred with the applicant's certification of a coastal consistency determination.

These examples are illustrative, not all-inclusive. An applicant should understand the permitting requirements, processes and schedules of applicable agencies when planning to apply for a license and construct a nuclear power plant. This guide does not contain guidance for preparing permit applications for submission to other agencies, including the USACE. Such guidance should be obtained from the applicable agencies. The Nuclear Energy Institute (NEI) prepared NEI 10-07, Revision 1, "Industry Guideline for Effective Interactions with Agencies Other Than NRC during the Early Site Permit Process," (Ref. 25), to provide guidance to applicants about interactions with other agencies. The NRC staff endorsed this NEI guidance by letter titled, "Endorsement of Nuclear Energy Institute 10-07, Revision 1, Industry Guideline for Effective Pre-Application Interactions with Agencies Other than the U.S. Nuclear Regulatory Commission during the Early Site Permit Process," dated March 12, 2013 (Ref. 26). In addition, applicants for an NRC permit or license should be aware that the USACE may be a cooperating agency with NRC for preparation of an EIS related to a proposed nuclear power plant.

IV. Impact Findings

Applicants should assess environmental impacts in proportion to their significance as described in 10 CFR 51.45(b)(1) which is based on requirements for Federal agencies as prescribed in the Council on Environmental Quality's (CEQ's) regulations for implementing NEPA at 40 CFR 1502.1, "Purpose," and consistent with the definition of "Significantly," at 40 CFR 1508.27.

In assessing the significance of environmental impacts, the NRC uses the following definitions of significance levels codified in the footnotes to Table B-1 in Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51:

- **SMALL:** For the issue, environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are small.
- **MODERATE:** For the issue, environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
- **LARGE:** For the issue, environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

V. Mitigation of Adverse Effects

Applicants are required to consider alternatives available for reducing or avoiding any adverse effects as described in 10 CFR 51.45(c). In addition, applicants should identify in their ERs any ongoing or planned mitigation for other permit-related activities and discuss the potential need for additional mitigation. Mitigation alternatives should be considered in proportion to the significance of the impact. In 40 CFR 1508.20, "Mitigation," the Council on Environmental Quality identifies five types of mitigative actions:

- avoiding the impact altogether by not taking a certain action or parts of an action;
- minimizing impacts by limiting the degree or magnitude of the action and its implementation;
- rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
- reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
- compensating for the impact by replacing or providing substitute resources or environments.

The applicant should identify in the ER all relevant, reasonably foreseeable mitigation measures that could reduce or avoid adverse effects, even if they are outside the jurisdiction of the NRC. The applicant should provide the reason why the mitigation measures are considered reasonably foreseeable. A mitigation measure can be considered reasonably foreseeable if, for example, it is 1) required by the NRC as a license condition (e.g., a requirement imposed pursuant to 10 CFR 50.54 (aa)), 2) required or likely to be required by another regulatory agency (e.g., USACE), or 3) mitigation that the applicant has stated to the NRC (e.g., in the Environmental Report) that it would perform. Where mitigation measures would be required by a license condition that should be clearly stated in the ER.

Where applicable, the applicant should specify what Federal, state, or local laws require the mitigation measures, or if there is (or is expected to be) a Federal, state, or local permit that requires the particular measures. The applicant should clearly explain the requirements that are being imposed by the

regulatory agency with authority over the resource and state how it relied on the mitigation to determine the impact level by discussing how the mitigation will be accomplished and whether it is expected to lower the impact level. For example, for a project where a wetlands mitigation plan is required by a state permit issued to the applicant and/or by state laws and regulations, the applicant should consider this information in the ER.

VI. Implementation of the LWA Rule – Definition of Construction and Preconstruction

On October 9, 2007, the NRC issued revisions to its rules related to LWAs (*72 Federal Register* [FR] 57416) (Ref. 27). The previous regulations had allowed for site preparation, excavation, and certain other onsite activities to proceed before a construction permit was issued, but only after NRC review and approval in the form of an LWA. With the new regulations, NRC authorization would be required only before undertaking activities that have a reasonable nexus to radiological health and safety or common defense and security. The revised rule clarified which activities are defined as “construction” and which activities are not considered construction. In discussing the environmental impacts of the proposed action, activities defined by the LWA rule as not constituting “construction” are referred to in this RG as “preconstruction” activities. Preconstruction activities are not considered direct impacts of the NRC’s Federal action because they may occur in the absence of an NRC license and are not part of the NRC’s licensing action. This change has implications for how impacts are described within the NRC’s EISs, even when the application does not include a request for an LWA.

According to 10 CFR 50.10(a), “construction” includes those activities such as driving of piles, subsurface preparation, placement of backfill, concrete, or permanent retaining walls within an excavation, installation of foundations, or in-place assembly, erection, fabrication, or testing, which are for:

- safety-related structures, systems, or components (SSCs) of a facility, as defined in 10 CFR 50.2, “Definitions”;
- SSCs relied upon to mitigate accidents or transients or used in plant emergency operating procedures;
- SSCs whose failure could prevent safety-related SSCs from fulfilling their safety-related function;
- SSCs whose failure could cause a reactor scram or actuation of a safety-related system;
- SSCs necessary to comply with 10 CFR Part 73, “Physical Protection of Plants and Materials” (Ref. 28);
- SSCs necessary to comply with 10 CFR 50.48, “Fire Protection,” and Criterion 3 of 10 CFR Part 50, Appendix A; and
- onsite emergency facilities, that is, technical support and operations support centers, necessary to comply with 10 CFR 50.47, “Emergency Plans,” and 10 CFR Part 50, Appendix E.

Construction does not include:

- changes for temporary use of the land for public recreational purposes;
- site exploration, including necessary borings to determine foundation conditions or other reconstruction monitoring to establish background information related to the suitability of the site, the environmental impacts of construction or operation, or the protection of environmental values;

- preparation of a site for construction of a facility, including clearing of the site, grading, installation of drainage, erosion and other environmental mitigation measures, and construction of temporary roads and borrow areas;
- erection of fences and other access control measures;
- excavation;
- erection of support buildings (such as, construction equipment storage sheds, warehouse and shop facilities, utilities, concrete mixing plants, docking and unloading facilities, and office buildings) for use in connection with the construction of the facility;
- building of service facilities, such as paved roads, parking lots, railroad spurs, exterior utility and lighting systems, potable water systems, sanitary sewerage treatment facilities, and transmission lines;
- procurement or fabrication of components or portions of the proposed facility occurring at other than the final, in-place location at the facility; and
- manufacture of a nuclear power reactor under a manufacturing license under Subpart F of Part 52 to be installed at the proposed site and to be part of the proposed facility.

The activities defined by 10 CFR 50.10, “License Required; Limited Work Authorization,” as not being included in the definition of construction are considered to be “preconstruction” activities because they may occur in the absence of an NRC license and are not part of the NRC’s licensing action.

Where this guide refers to “building,” it includes all preconstruction and construction activities. Under the revised LWA rule, the applicant should separate the impacts of preconstruction and construction activities to address the latter, as they are the activities being authorized. The applicant should also describe the impacts of the preconstruction activities, so they can be evaluated as part of the cumulative impacts related to the construction activities.

Generally, the estimates of the impact breakdown between preconstruction and construction activities do not need to be detailed. For example, estimated breakdowns such as 70–30 percent or 60–40 percent or 50–50 percent should be sufficient to inform the decision-making process under the NEPA. The socioeconomic impacts of the construction activities can be apportioned simply based on these estimates.

In a few areas, the level of impact may be so small that anything other than a ballpark estimate of the separation would not be warranted to appropriately inform the NEPA decision-making process. Based on experience from other construction projects of similar size, the air quality impact will probably be assessed as small during scoping, if the area is in attainment under EPA regulations. Under these circumstances, no effort beyond a very simple estimate of the preconstruction-construction impact separation, such as 50–50 percent, would be necessary to assess the impact of the construction activities.

In addition, the staff anticipates that the USACE will be a cooperating agency on the majority of EISs because it is likely to have permitting actions related to the preconstruction and construction activities and, in some cases, operational activities for the plant. The USACE views the impacts from preconstruction and construction activities as impacts of the proposed project based on USACE regulations. The NRC and the USACE will cooperate on the EISs in accordance with the Memorandum of Understanding signed on September 12, 2008 and published in the *Federal Register* (73 FR 55546) (Ref. 29), covering environmental reviews related to the issuance of authorizations to construct and operate nuclear power plants. The NRC and the USACE established the cooperative agreement because

both agencies have concluded it is the most effective and efficient use of Federal resources to write one EIS that will address both agencies' NEPA obligations.

VII. Storage of Spent Fuel

In 2014, the NRC issued a revised rule at 10 CFR 51.23, "Environmental impacts of continued storage of spent nuclear fuel beyond the licensed life for operation of a reactor," and published NUREG-2157, "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel" (Ref. 30). As a result of the revised rule, the environmental impacts of the continued storage of spent fuel (beyond the licensed life of the plant), are deemed incorporated into an EIS for a new reactor review. As part of the basis for the analysis in NUREG-2157, the NRC staff assumed that an independent spent fuel storage installation of sufficient size to hold all of the spent fuel from operations would be built during the licensed life of the plant. The applicant should be cognizant of the analysis in NUREG-2157, and should provide a discussion of its plans for management of spent fuel during the licensed life of the plant.

VIII. Presentation of Applicant Information

Information and data should be discussed in qualified terms within the ER, and appropriate background information and data should be provided in or with the application at a level sufficient for the NRC staff to make an impact level determination. The applicant should describe and provide the following data and information:

- geographic information and geospatial data used to support analyses, including appropriate description of the data formats and sources of the information;
- data formats used to create figures and maps; and
- description and documentation of any computer modeling codes that are used to support analyses in sufficient detail to allow the NRC staff to reproduce the model results.

Information obtained from publications or other information from the literature should be concisely summarized and documented using references to original data sources. Where the availability of original sources that support important conclusions is limited, the sources should be adequately summarized in the application and should be available for auditing in the applicant's records. In all cases, information derived from published results should be clearly distinguished from information derived from the applicant's field measurements.

The information the NRC uses to conduct and inform its NEPA environmental reviews, including information in the ER, must be publicly available, as appropriate. Therefore, applicants should ensure that the information included in the ER can be made publicly available. Applicants should also ensure consistency of information presented within different sections of the ER, as well as between the ER and the safety analysis report.

Chapter 1

1.0 Introduction

1.1 Plant Owners and Reactor Type

The owner(s) and the applicant(s) for the proposed project should be specified. Other information that should be provided is specified in 10 CFR 50.33, “Contents of applications; general information.” Information required on reactor type and ownership can reference the information required in the safety analysis report (see 10 CFR 52.17, “Contents of applications; technical information,” and 10 CFR 52.79, “Contents of applications; technical information in final safety analysis report”).

1.2 Description of the Proposed Action and the Purpose and Need

According to 10 CFR 51.45(b), “Environmental report,” the Environmental Report (ER) “shall contain a description of the proposed action” and “a statement of its purposes”. The purpose and need statement is the foundation of the environmental analysis on which the rest of the environmental impact statement is built. The purpose and need statement is developed by the U.S. Nuclear Regulatory Commission (NRC) staff, but is informed by the applicant’s objectives,¹ as stated in Chapter 1 of its ER.

The purpose and need has typically been described in terms of providing a specific quantity of baseload electricity to a defined service area within a defined time period. However, the purpose and need is not required to be restricted to baseload generating capacity. As discussed in Chapter 8 of this regulatory guide, an applicant may use different means than a baseload generating capacity analysis to demonstrate the need for the power to be provided by the proposed project. In addition, the purpose and need statement may address additional needs other than the production of electricity. Additional purposes or needs for the project will provide greater insight to the benefits and assist NRC staff in defining reasonable alternatives to the proposed project. Additional purposes could include, but are not limited to, the following:

- meeting greenhouse gas emission goals
- replacing existing plants
- meeting State or Federal energy policy goals
- enhancing energy diversity
- consideration of Federal policy not related to environmental quality (10 CFR 51.71(d))

However, it is the production of electricity that allows the project to be justified in terms of benefits. The purpose and need statement cannot be so restrictive that there are no alternatives, other than the proposed project, that would meet the purpose and need. For example, the purpose and need could not be to build and operate a specific light-water reactor design at a specific location. In that case, there would be no alternative energy technology or site that would meet that purpose and need statement. An alternative is not reasonable if it does not meet the purpose and need statement.

¹ 40 CFR 1502.13 defines purpose and need as follows: The statement shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action.

1.3 Planned Activities and Schedules

The applicant should supply a schedule of planned activities including dates for the start of building and full-power operation. These dates are used in the analyses for construction, operation, and cumulative impacts, and need for power.

1.4 Status of Compliance

In accordance with 10 CFR 51.45(d), the ER shall:

- “list all Federal permits, licenses, approvals and other entitlements that must be obtained in connection with the proposed action”
- “describe the status of compliance with these requirements”
- “include a discussion of the status of compliance with applicable environmental quality standards and requirements including, but not limited to, applicable zoning and land-use regulations, thermal and other water pollution limitations, or requirements which have been imposed by Federal, State, regional, and local agencies having responsibility for environmental protection”

Chapter 2

2.0 The Proposed Site and the Affected Environment

As specified by 10 CFR 51.45(b), the environmental report (ER) shall contain “a description of the environment affected” by the proposed action. The information in this chapter of the ER should present the relevant information concerning those physical, ecological, societal, and human characteristics of the environment in and around the proposed site that might be affected by building and operation of a proposed nuclear station.

The applicant should provide proposed plant location information (e.g., State and county in which the site will be located), an aerial photograph of the site as it exists at the time of the application, and one or more maps showing the site location and plant arrangement within the site, including the extent (if any) to which the plant is co-located and/or interfaces with an existing power plant. The applicant should provide coordinates for and the total acreage of the proposed site. In addition, this section can be used to provide other descriptive information about the setting of the proposed project.

2.1 Land Use

The applicant should provide data and information about the site, local vicinity, and the wider region. For the purposes of this section, the site is defined as the immediate property effectively controlled by the applicant (e.g., within the site boundary), upon which the station would be situated. The vicinity is the surrounding landscape encompassing the site, local access routes, nearby cities and towns, and other local resources with the potential to be affected by the station. The region includes the vicinity and the wider surrounding area. Definition of vicinity and region is left to the discretion of the applicant; however, as a general suggestion, a typical distance limit of a 6-mi radius from the site perimeter can be used for vicinity and a 50-mi radius from the site perimeter can be used for region. The vicinity should be large enough to encompass surrounding areas whose land uses could substantially be influenced by the station and associated facilities. The region should be large enough to encompass any areas encompassed by applicable regional land-use or local economic-development plans.

The vicinity should include any offsite areas upon which related plant structures would be sited or routed. Examples include transmission facilities (e.g., switchyards, substations, and transmission-line towers), and access roads needed to connect the plant to the grid. Other examples include reservoirs, barge slips, water-intake facilities, blowdown or other discharge lines, and related infrastructure.

The applicant should identify and describe the land-use characteristics of the site, vicinity, and region. These descriptions should provide reasonably foreseeable land-use changes near the site, including commercial, residential, and industrial developments and the anticipated effects of land-use or related regional-development plans.

2.1.1 Site, Vicinity, and Region

The ER should include the following land-use information relating to the proposed site, vicinity, and region:

- A site area map prepared according to Regulatory Guide (RG) 1.206.
- Zoning information for the proposed site including any existing or proposed land-use plans and any regional economic-development plans that include the proposed site or vicinity within their scope.

- Maps and summary tabulation of areas occupied by the principal land uses for the site, vicinity, and region.
- Map showing existing topography of the site and vicinity.
- Maps showing highways, railroad lines, waterways, and utility corridors located on, or that cross, the site, vicinity, and region.
- Special land uses (e.g., recreation areas, parks, Tribal lands, designated wild and scenic rivers, or areas of other special designation) that could be affected by building the proposed project.
- Raw material resources (e.g., timber, sand and gravel, coal, oil, natural gas, ores, groundwater, and geothermal resources) and the owners thereof on or adjacent to the site that are presently being extracted or are of known commercial value.
- Principal agricultural and forest products of the vicinity and region, if agriculture or forestry is a predominant land use.
- Maps showing major public and trust land areas in the region.
- Discussion of whether any land at the proposed site or any affected offsite lands would be subject to requirements in the Coastal Zone Management Act (16 U.S.C. 1451 et seq.).
- Discussion of whether any land at the proposed site or any affected offsite lands constitute prime or unique farmlands (7 CFR 657, “Prime and Unique Farmlands” (Ref. 31)).
- Maps and discussion of any floodplains or wetlands on the site (can cross reference to other ER sections).
- Discussion of whether the applicant intends to acquire additional land to expand the proposed site.
- All associated geographic information system (GIS) coverages used to produce the map products in the ER.
- Brief discussion of the major geological aspects of the site that could influence land use, including brief descriptions of soil and rock types, and unique geologic features (e.g., karst; geothermal resources; paleontological resources; unique formations, outcrops, or exposures of special interest (e.g., glacial erratics); and water supplies). Reference the final safety analysis report for detailed geologic, seismologic, and geotechnical information.

2.1.2 Transmission-Line Corridors and Other Offsite Areas

Construction or upgrading of electric power transmission lines to serve a nuclear power plant does not require U.S. Nuclear Regulatory Commission (NRC) approval (10 CFR 50.10(a)(2)). The NRC recognizes that new transmission lines and corridors may not necessarily be constructed or owned by an applicant seeking a permit or license from the NRC. However, the impacts of new transmission lines and corridors are relevant to the NRC’s analysis of cumulative impacts in an environmental impact statement (EIS) (10 CFR 51.45(c)).

The ER should include discussion of the following land-use information relating to (1) offsite corridors or areas that would be affected by the construction and operation of electric power transmission lines or other offsite project elements, (2) new transmission corridors, and (3) construction activities that would occur in existing transmission corridors:

- description of new transmission-related facilities (e.g., transmission lines and substations) that would be needed, including voltage specifications and the name of the entity that would construct

and own any new transmission-related facilities and the associated process for obtaining approved rights-of-way;

- map showing the potential or planned routing (i.e., the specific route or a band encompassing the route) of any new or existing (affected by the proposed project) transmission corridor(s) and location of transmission-related facilities;
- tabular summarization of the dimensions (length and width) of affected transmission corridors by each specific corridor segment or right-of-way;
- tabular summarization of existing land use and land cover within affected transmission corridors and other offsite areas (e.g., pipeline corridors);
- highways, railroad lines, and utility corridors crossed by new transmission lines or access corridors;
- special-use land areas that would serve as constraints in the selection of transmission-line routing or other offsite project activities (e.g., pipeline corridors);
- location of any project activities that would be in a floodplain, on wetlands, or on a waterbody;
- discussion of whether any land used for new transmission corridors or other offsite building activities would be subject to the Coastal Zone Management Act (16 U.S.C. 1451 et seq.);
- discussion of whether any land that would be used for new transmission corridors or other offsite building activities would constitute prime or unique farmlands (7 CFR 657);
- discussion of any expected private land access requirements;
- description of proposed routes of access corridors (e.g., roads and railroads) to serve the proposed project and any land-use restrictions or land-use plans affecting such corridors; and
- all associated GIS coverages used to produce the map products in the ER.

2.2 Water Resources (Surface Water and Groundwater)

The applicant should provide data and information over the appropriate region of interest (ROI) to establish the bases for estimates of the effect of station building and operation on water resources (surface water and groundwater) and its uses and users. For the purposes of this section, the ROI may be defined as the station and the surrounding area out to a distance sufficient to encompass those water resources or that may be reasonably assumed to be affected by the building or operation of the station. For groundwater resources, the ROI may generally be defined by the extent to which building or operation of the plant affects the underlying aquifers. For reclaimed water, such as treated wastewater (if to be used), the ROI may generally be defined by the extent of its prospective uses and users.

The applicant should describe, in quantitative terms, the hydrological and chemical characteristics of surface-water and groundwater bodies in the ROI. In addition, water use within the ROI should be described. The amount of data and information provided should be sufficient to evaluate the effects of station building and operation on water resources, and is anticipated to depend on the magnitude of the potential impacts. Greater potential impact will require more data and information to support the evaluation. Alternative interpretations of data and characteristics should be described when reasonable or when uncertainty in impacts exist. Characteristics should be substantially based on data obtained from a pre-application monitoring program and integrated with data from other studies conducted in the area and region (as applicable).

A statistical description should accompany all data. Average or median values, standard deviations or interquartile range, and the historical extremes should be described. Temporal trends in characteristics, including seasonal variation, should be identified and explained. Temporal variations of important characteristics (e.g., river flow rates) should be described in sufficient detail to provide accurate evaluation of impacts. For many characteristics, monthly variations may be sufficient, but daily or shorter increments should be provided when important for evaluating environmental impacts. Spatial variations of characteristics (e.g., aquifer hydraulic conductivity) should be described when important for evaluating environmental impacts (e.g., radionuclide transport in groundwater).

All data for characteristics, including water use, should be adjusted to both present-day conditions and to those that may reasonably be expected to occur over the proposed period of the license. Where features of a proposed station (e.g., foundations, excavations, artificial lakes, and canals) modify the hydrologic conditions, the applicant should furnish sufficient site-specific detail to justify evaluation of the effects from building and operating the station on hydrologic characteristics, water use, and potential radionuclide transport. In addition, the applicant should describe reasonably foreseeable changes in the hydrologic environment (e.g., climate and land use).

When a mathematical model is used to support the evaluation of hydrologic characteristics, the applicant should describe the conceptual basis for the model, including the rationale for eliminating plausible alternative conceptualizations, the assumptions used in developing the model, the range of applicability of the model, input data used, the basis for boundary conditions, parameter estimation and calibration procedures followed, and estimates of uncertainty in model forecasts. The applicant should provide sufficient data to permit staff evaluation of modeling results, including input files used to obtain the model results and a description of any post-modeling analyses used by the applicant.

2.2.1 Hydrology

The applicant should describe the hydrologic characteristics of surface waterbodies and groundwater aquifers that could be affected by station water use or be affected by building or operating the station. These characteristics collectively define the supply of water within the ROI, including the location, quantity, and temporal variability of that supply. The applicant should include the following information in the ER:

- Discussion of rivers and streams including, but not limited to, drainage areas and gradients, discharge, bathymetry, wetlands and floodplain descriptions, flood and drought characteristics, flood control measures, and other hydrographic modifications.
- Discussion of lakes and impoundments including, but not limited to, bathymetry, temperature, currents, inflows and outflows, evaporation, seepage, and a description of reservoir characteristics (e.g., elevation-area-capacity curves) and operations.
- Discussion of estuaries and oceans including, but not limited to, bathymetry, tidal and nontidal currents, temperature, salinity, sedimentation rates, and sediment gradation and sorption characteristics.
- Discussion of groundwater including, but not limited to, descriptions of aquifers and confining units, recharge and discharge areas and fluxes, groundwater head contour maps, hydraulic gradients, permeabilities, total and effective porosities, advective travel times, bulk density, and storage coefficients.
- Groundwater transport characteristics (e.g., dispersion and adsorption coefficients), when necessary to evaluate impacts.

- Data concerning use of groundwater including drawdown 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.
- Maps or figures showing information requested above, as appropriate (e.g., areas affected by saltwater intrusion).

2.2.2 Water Use

The applicant should provide present and known future surface-water, groundwater, and reclaimed water uses (as applicable) that could affect or be affected by building or operation, including for the following uses: public and self-supplied (or private) withdrawals for domestic, municipal, industrial, agricultural, mining, and power generation uses.

Data and information provided for each use should include, but not be limited to, the following:

- location and nature of water users and water-use areas;
- distance from the station;
- withdrawal rate by use category and return rate; and
- statutory or other legal restrictions on the water use or the water resource.

Additional information for groundwater use should include the following:

- identification of the aquifer from which withdrawal occurs;
- location and depth of wells;
- identification of any U.S. Environmental Protection Agency (EPA)-designated sole source aquifers that may be affected by station building or operation;
- characterization of consumptive and nonconsumptive water uses over the ROI;
- temporal variations in consumptive and nonconsumptive water uses; and
- existing capacities of local and regional water and wastewater utilities.

Station water-use requirements are not addressed in this chapter; however, Chapter 3 of this RG addresses the information to be included in the ER related to station water-use requirements.

2.2.3 Water Quality

The applicant should describe the water-quality characteristics of surface waterbodies, groundwater aquifers, and reclaimed water that could be affected by station water use and effluent disposal. Data and information should include, but not be limited, to the following characteristics:

- physical (e.g., temperature),
- chemical (e.g., pH); and
- biological (e.g., biological oxygen demand).

The mean, range, and temporal and spatial variation of these water-quality characteristics should be provided. Data should be gathered for a sufficient period of time to understand long term (annual) and short term (seasonal or other) variations in both quality and availability of water (flow rates, water levels, etc.).

A description of existing aquatic environmental stressors, including a list of any Clean Water Act 303(d)-impaired waters, should be provided. The applicant should identify, to the extent possible, the source and nature of existing impairments. Status of the permitting process for the Clean Water Act (33 U.S.C. 1251 et seq.) 401 certification should also be described.

2.2.4 Water Monitoring

The purpose of the pre-application monitoring program is to establish a baseline for assessing subsequent environmental effects attributable to building and operating the proposed station. The applicant should describe the pre-application monitoring program used to assess the characteristics of the surface-water and groundwater resources in the ROI.

The ER should describe the pre-application monitoring program in sufficient detail to demonstrate a thorough and comprehensive approach to environmental assessment. The adequacy of the monitoring program with respect to both spatial coverage (i.e., surface area and depth), and temporal coverage (i.e., duration and sampling frequency) should be demonstrated. The description of this program should include the following:

- locations of monitoring stations;
- frequency and duration of monitoring;
- monitoring equipment used;
- sampling and analysis procedures followed;
- data analysis methods used; and
- documentation of any data-quality objectives.

2.3 Ecological Resources

The ER should describe the terrestrial, wetland and aquatic ecological resources existing at the proposed project site and in the vicinity and region. The applicant should provide sufficient details in the ER as a baseline for determining the impacts to terrestrial, wetland and aquatic species and habitats that might be affected by building and operation of the proposed nuclear station.

2.3.1 Terrestrial Ecology

The ER should include a baseline description of terrestrial resources on the proposed project site, and in the vicinity and region. The description should also address offsite parcels and corridors needed for components such as reservoirs, barge docks, heavy-haul roads, access roads, laydown areas, electric transmission lines, water pipelines, and mitigation sites. When describing terrestrial resources, the applicant should use the same definitions of vicinity and region as defined for the land use sections of the ER. The baseline description should focus on the anticipated footprint of land disturbance and may be less detailed for peripheral areas. Much of the needed information may be summarized from the background reports prepared using RG 4.11. Information should be updated to reflect recent land-use changes and natural successional processes.

Terrestrial Habitats

Detailed guidance on identifying and describing terrestrial habitats is provided in RG 4.11. The ER should include the following information to characterize terrestrial habitats:

- Identification and description of each ecoregion (or equivalent) encompassed by the site, offsite parcels and corridors, vicinity, and region using a widely recognized system such as that used by the EPA (EPA Ecoregion maps).
- Figures identifying and mapping each terrestrial habitat on, or adjacent to, the site (or offsite parcels or corridors).
- Description of each terrestrial habitat type using guidance provided in RG 4.11. Detailed field survey or quantification of vegetation characteristics may not be necessary. Descriptions based on recent site observations are typically more useful than older or regionalized descriptions. Studies would ideally show the condition of the ecological resources that exist no more than 5 to 10 years prior to NRC receiving the application. If older ecological baseline data is used, a discussion of the basis for determining that the data provides for an accurate and meaningful evaluation of potential impacts should also be included.
- Tables estimating the area of each habitat onsite (or offsite parcels or corridors).
- A table estimating the approximate area (or percentage) of each habitat type in the vicinity (or some other meaningful subset of the landscape surrounding the site).
- A qualitative discussion of terrestrial habitat in the region.

Wetlands

Wetlands are specialized habitats with properties intermediate between terrestrial and aquatic. The Federal definition of wetlands is presented in 33 CFR 328, “Definitions of Waters of the United States” (Ref. 32), but not all areas meeting this definition are subject to Federal regulatory jurisdiction. Unregulated areas meeting the Federal definition are termed non-jurisdictional wetlands. Some states and localities regulate wetlands independently using definitions that may vary from the Federal definition. Wetland information presented in the terrestrial ecology portions of the ER should not conflict with wetland information presented in the aquatic ecology portions. Regulatory Guide 4.11 provides additional guidance on wetlands. In general, the ER should include the following information with respect to characterizing wetlands:

- An indication of whether a wetland delineation has been completed for the site and offsite parcels, what areas were addressed, and what wetland procedure was used.
- A wetland delineation map and identification of each wetland using a classification system such as that used in the U.S. Fish and Wildlife Service (FWS) National Wetlands Inventory (Ref. 33), for those areas addressed by wetland delineation.
- A description and estimate of the area of each wetland falling under each National Wetlands Inventory classification
- Wetland mapping data from a published source (e.g., the National Wetlands Inventory maps or state wetland maps) or identification of the terrestrial habitats on the site, if any, that may contain wetlands for those project areas where no wetland delineation was performed.
- A discussion of the functions and values of each wetland or cluster of interrelated wetlands (sometimes referred to as an “assessment area”) on the site or offsite parcels.
- Citation and summary of any jurisdictional determination issued by an agency. For project areas lacking a jurisdictional determination, a description of the anticipated process for acquiring one.
- Identification, when possible, of whether each wetland is under the jurisdiction of the Clean Water Act or applicable State or local wetland protection laws.

- An estimate of the approximate extent of wetlands in the vicinity using National Wetland Inventory maps or another source and a separate estimate for each National Wetland Inventory class or for each mapping unit used.
- An estimation of the wetland losses in the context of their relative abundance in the surrounding landscape.
- A qualitative discussion of wetlands in the region including the typical landscape positions commonly occupied by wetlands in the region (e.g., stream valleys, estuarine or lacustrine fringes, and topographic depressions), and the history of wetland disturbance in the region.

Wildlife

Guidance on identifying terrestrial wildlife is provided in RG 4.11. The ER should include the following:

- Tables of wildlife species observed in each habitat (upland or wetland) on the site (and each offsite parcel or corridor) based on a minimum of one year of observations, if available. See RG 4.11 for additional direction.
- A discussion of the potential value of each habitat to each major wildlife grouping: mammals, birds, reptiles, amphibians, and insects. The discussion can be qualitative and should have an ecological focus; discussions individualized to species are not usually necessary.
- A discussion of wildlife activities that have the potential to substantially alter the composition or distribution of terrestrial habitat (e.g., overbrowsing or burrowing).
- A discussion of possible wildlife movement and migration patterns. The discussion may be generalized and does not need to be based on field observations.
- A discussion of wildlife used for subsistence or recreational hunting.

Important Species and Habitats

Guidance on important terrestrial species and habitats is provided in RG 4.11 and Table 2-1. Note that important species and habitats include, but are not limited to, threatened or endangered species and critical habitats. The ER should include the following information on important species and habitats:

- Each important terrestrial species or habitat known to occur or that has a reasonable likelihood of occurring in the project area. Briefly indicate why each meets the criteria for importance in Table 2-1.
- A brief description of each important terrestrial habitat, which can cross reference the habitat descriptions already provided.
- A brief paragraph for each important terrestrial species, which provides key data on habitat requirements and life history as necessary to support an assessment of potential effects from the project.
- A discussion related to any correspondence that has been initiated with the FWS or State, local, or Tribal natural resource agencies on important species or habitats (Table 2-1) including endangered, threatened, or special status species. Briefly summarize and provide copies of key correspondence (e.g., letters, e-mail, or phone call summaries).

Table 2-1. Important Species and Habitats to be considered in the ER^a

| Species | Habitat |
|---|--|
| <p>Federally threatened or endangered and proposed species for listing by FWS or National Marine Fisheries Service (NMFS) that occupy habitat or have an ecosystem function that may be affected by the proposed project</p> <p>Candidate species of particular interest to the review that occupy habitat or have an ecosystem function that may be affected by the proposed project</p> <p>Representative State status species of particular interest to the review</p> <p>Other species for which a Federal or State agency has established a monitoring requirement at or near the site</p> <p>Representative commercially or recreationally valuable species</p> <p>Potentially significant nuisance or invasive species</p> <p>Other species of known or indicated interest</p> | <p>Federally designated or proposed critical habitat or essential fish habitat.</p> <p>Protected areas such as sanctuaries, parks, refuges, or preserves, including marine protected areas</p> <p>Habitats identified by Federal or State agencies as unique, rare, or of priority for protection; e.g., areas that have been designated as habitat for an evolutionary significant unit, distinct population segment, critical habitat, or essential fish habitat</p> <p>Other habitats of known or indicated interest, e.g., known breeding, spawning, nesting, or nursery grounds</p> |
| <p>(a) The criteria presented in this RG represent updated guidance developed by the NRC subsequent to the publication of RG 4.11. The guidance in RG 4.11 reflects the guidance in the Environmental Standard Review Plans at the time the documents were developed.</p> | |

2.3.2 Aquatic Ecology

The ER should include a baseline description of the aquatic resources on the site and in the vicinity and region. The description should also include any waterbodies that could reasonably be expected to exhibit detectable changes to aquatic resources from building and operating of the new facility. This includes waterbodies associated with offsite transmission and pipeline corridors, large component transport routes, and any other affected offsite areas. The description should focus on the information that is needed for the evaluation of potential impacts to the aquatic environment that may result from building and operation.

For the purposes of this section, vicinity is defined as the area (not on the site) that would potentially be affected by the direct and indirect impacts of building and operations. The region is defined as the site, vicinity, and the wider surrounding area. It encompasses areas that influence the site and vicinity (for example the tributaries on a river). The ER should clearly describe the vicinity and region for the aquatic ecosystem. The amount of detail and description provided for the region would be brief in comparison to the description of the proposed site, vicinity, and any affected offsite project areas such as the transmission and pipeline corridors.

Regulatory Guide 4.24, “Aquatic Environmental Studies for Nuclear Power Stations” (Ref. 34), provides guidance on designing and implementing aquatic environmental studies for baseline descriptions and for impact analysis. The subsections below address specific elements of characterizing baseline aquatic conditions, including aquatic habitats, organisms, and important species and habitats.

Aquatic Habitats

The ER should include the following information to characterize aquatic habitats:

- A description of the aquatic environment, including the relative significance of habitats in waterbodies onsite or in the vicinity of the site, including those that would be used for plant cooling or that could be affected by other activities.
- Maps or figures, including electronic layers, showing waterbodies and aquatic habitats on the proposed site and in the vicinity and region, including the natural structure of the benthic habitat, the location and depth of any associated underwater structures in the vicinity of the site (e.g., submerged dams), and the proposed location of the intake and the discharge systems. Similar maps and figures of transmission and pipeline corridors that extend offsite or other affected offsite areas and their relationships to waterbodies and aquatic habitats.
- A discussion of the existing aquatic habitats in the vicinity of the proposed intake and discharge structures and associated systems.
- Bathymetry, substrate, and other habitat information, including maps or figures, for the affected aquatic habitats in the vicinity of plant structures including the discharge and intake facilities.
- A description of any natural, anthropogenic, and pre-existing environmental stressors and the current ecological conditions indicative of such stresses.

Aquatic Organisms

The ER should include the following information to characterize the aquatic organisms:

- Distribution and abundance data for fish and macroinvertebrates found on the site and in the vicinity. Data should be collected for a sufficient period of time and frequency and from locations that will provide an understanding of the long term (annual) and short term (seasonal or other) variations in distribution and abundance of species potentially affected by building and operation. Studies would ideally show the condition of the ecological resources that exist no more than 5 to 10 years prior to NRC receiving the application. If older ecological baseline data is used, a discussion of the basis for determining that the data provides for an accurate and meaningful evaluation of potential impacts should also be included. Data collection should be consistent with the guidance on baseline studies presented in RG 4.24.
- Locations and values of local commercial, subsistence, and recreational fisheries and the historic and current seasonal distributions of harvest by species.
- List and description of species essential to the maintenance and survival of commercially or recreationally valuable species.
- Presence, distribution, and abundance of key aquatic indicator organisms (e.g., diatoms, benthic macroinvertebrates, submerged aquatic vegetation, and fish) that could be used to gauge changes in habitat quality, biodiversity, and the distribution and abundance of species populations. Key indicator organisms are those that would be particularly vulnerable to impacts on forage or habitat.
- Presence of nuisance, invasive, and introduced species, including fish, aquatic vegetation, and benthic invertebrates (e.g., *Corbicula* spp. or *Mytilus* spp.) onsite or in the vicinity.
- Presence of disease and parasite outbreaks (e.g., viral hemorrhagic septicemia affecting North American salmon and trout, the myxosporean parasite (*Myxobolus cerebralis*) that causes

whirling disease, or the marine dinoflagellate responsible for red tide (*Karenia brevis*) that could potentially be affected by operations.

Important Species and Habitats

The ER should provide the following information to characterize important species and habitats as defined in Table 2-1:

- A description of important aquatic species or habitat using the guidelines in Table 2-1 and a brief description of why each meets the criteria in Table 2-1. Additional guidance on identifying important species and habitats is provided in RG 4.24.
- A brief discussion for each important species (or representative species as indicated in Table 2-1), which considers all life stages necessary to support an assessment of potential effects on the species from the project. Include a description of their temporal and spatial (including depth) distribution and abundance and any observed occurrence in relationship to the intake and discharge sites and frequency of observations, if appropriate.
- A summary related to any correspondence or discussions with the FWS, NMFS, or State, local or Tribal natural resource agencies on important species or habitats associated with the proposed project (Table 2-1) including endangered, threatened, or special status species and federally designated critical habitat. Briefly summarize and provide copies of key correspondence (e.g., letters, e-mail, or phone call summaries).

When proposed new transmission corridors, pipeline corridors, or affected offsite areas would intersect or be adjacent to aquatic resources, the following information should be included in the ER to the extent the information is available to the applicant:

- A map or figure and description of the location of important aquatic species and habitats known or expected to be present in the vicinity of the transmission and pipeline corridors and affected offsite areas together with any specific habitat requirements or community interrelationships; e.g., areas that have been designated as an evolutionary significant unit, distinct population segment, critical habitat, or essential fish habitat.

2.4 Socioeconomics

The applicant should provide sufficient data and information in the ER to establish the environmental baseline for estimates of socioeconomic effects, including: the demographic region, and the economic region. The demographic region is defined as the site and the surrounding area within a 50-mi radius from the center of the proposed site. The 50-mi radius should encompass the majority of population groups potentially affected by building and operations. The economic region is defined as the subset of counties (or other appropriate identifiable geographic grouping) within the 50-mi demographic region where the applicant believes the majority (80 percent or more) of socioeconomic impacts will be experienced.

Socioeconomic assessments should also include the following:

- reasonable projections about the affected region for the expected license period of the proposed project; and
- a detailed discussion of the methodologies used to develop each projection.

2.4.1 Demographics

The ER should provide detailed information about the characteristics for the proposed demographic region, with special emphasis on the economic region, to define the magnitude of any potential social or economic impacts from building or operating the proposed project. The applicant should rely upon the most recent demographic estimates available (preferably from a single source) for the demographic region that can be disaggregated to the Census block group (CBG) level for all demographic subcategories. The data source used should match the data source used for environmental justice (EJ) analyses performed in the ER.² The ER should include the following information related to demographics:

- Racial and ethnic categories by county or other important geographical area in the demographic region (see the discussion of environmental justice in this RG for additional guidance). At a minimum, demographic data should include the following racial and ethnic categories:
 - White (Not Hispanic or Latino)
 - African American or Black
 - American Indian or Alaska Native
 - Asian
 - Native Hawaiian or Other Pacific Islander
 - Other Race (including races not mentioned above and “Two or More Races”)
 - Ethnicity: Hispanic, Latino, or Spanish origin (may be of any race)
 - Aggregate minority (calculated as “Total Population” minus “White, not Hispanic or Latino”)
- An overview map and accompanying tables identifying the counties and principal cities and towns that pertain to the demographic region and the economic region.
- A table providing historic and projected population data for the counties of the demographic region, with summary totals for the counties pertaining to the economic region. Population values should include historic data for the previous two decennial censuses and extend forward to at least the decennial year after the expected license period of the proposed project.
- A table providing the current racial and ethnic distribution of the population, accompanied by discussion of expected trends in racial and ethnic distribution over the license period.
- A discussion of any current migrant workforce or other migrating population (see latest Census of Agriculture). Discuss the historic and expected trend for migrant populations.

² Because the 2010 decennial Census did not report income, individuals or households in poverty, those data are only available at the Census block group level through the American Community Survey (ACS) 5-Year Estimates. These ACS data have become the NRC staff’s principal source for all demographic analyses (including environmental justice analyses) for new reactor licensing.

- A table and accompanying discussion of transient populations affected by the proposed action, including an assessment of local public venues (e.g., stadiums or arenas, resident camps, large employers, and parks and recreation areas) with the following information:
 - distance from the site
 - peak visitation levels
 - timing of the peak visitation levels
 - attendance levels
 - dates of activities
 - other pertinent information
- A table presenting the current income distribution, including household income by segments (e.g., by quartiles), Federal median household income level, and the number and percent of households below the Federal poverty level for each county in the demographic region, and each state within the demographic region. Discuss current trends affecting incomes within the demographic region.

2.4.2 Community Characteristics

Sufficiently detailed information about the economic characteristics of the proposed site and vicinity forms the baseline for the assessment of any economic impacts that might occur because of building- or operation-related activities at the proposed site. The ER should focus primarily on the community characteristics for the economic region surrounding the proposed site. However, there may be areas beyond the demographic region that have a unique importance to the project or for cumulative impact purposes, and the applicant should include such areas in the discussion when identified.

The ER should include information related to community characteristics including a table and/or chart illustrating the following:

- Information related to the current site labor force (if the proposed site is co-located with an existing power plant), including the peak number of operations workers, a characterization of all temporary outage workers, and the county-level residential distribution of the current operations workforce and temporary outage workers.
- Housing information, including sales and rental markets in the economic region, the number and types of units available for rent or sale, vacancy rates, and trends. The applicant should only include habitable structures and the location of existing and projected housing developments.
- The region's current and historic economic base, including important regional industries by category, employment, and size. Describe the nature of the heavy construction industry and construction labor force in the region and the total regional labor force, regional unemployment levels, and future economic outlook projected for the proposed license term.

The ER should identify local and regional planning and administrative organizations and discuss their analyses and trends that may affect conditions, including:

- The region's current governmental structure including regional political jurisdictions, school districts, and taxing jurisdictions (including those taxing jurisdictions that would be most affected by the proposed project). Tax rate data should be provided for:
 - Federal, State, county, regional, school district, sales and use, and other applicable tax sources and their rates;

- any current agreements for the proposed or existing site for special property tax rates;
- payment-in-lieu-of-taxes; and
- other in-kind payments to local jurisdictions.
- The current educational system within the economic region (i.e., public and private primary and secondary schools and higher education institutions) including capacity; student counts; present percentage of utilization; student-teacher ratios; and expected trend affecting these resources.
- A review and discussion of the local land-use plans and zoning information relevant to population growth, housing, and changes in land-use patterns within the economic region and relevant trends that would affect the development of the economic region.
- A summary, in tabular form, of local social services and public facilities (e.g., water and sewer); present and projected police and fire capabilities; and medical information including hospitals (available beds and occupancy rates) and number of medical doctors and specialized health facilities.
- The name and location for each water- and sewer treatment facility, its design capacity, current usage rate, and any information about future expansions or other pertinent changes, in each county and community in the economic region.
- A summary, in tabular form, of access routes to the site of roads (including highways), rail, and waterways. For each mode of transportation, provide a discussion of significant proposed and potential expansions, improvements, and upgrades. Information on transportation should be consistent with information provided in the land use; non-radiological health; and fuel cycle, transportation and decommissioning sections in this RG.
 - Roads: Include carrying capacity and condition, availability and type of public transportation; and planned modifications that might affect traffic flow to and from the proposed plant site. Describe road and highway use in industry-standard terms (e.g., Level of Service designation or similar process). Discuss current and projected trends for usage of these routes, including any existing plant-related commuter patterns for operations and outages. State whether or not heavy-haul roads will be needed.
 - Rail: Describe railroads with regard to quality, capacity of the tracks, proximity to the proposed site, road crossings, and the availability of spurs to the proposed site.
 - Waterways: Waterway infrastructure refers to freshwater and ocean barge facilities. Describe all barge facilities (e.g., size, size limitations, and depth of channel).
- Potentially affected visual resources within the expected viewshed of the station (e.g., light pollution). Describe any existing standards or applicable regulations affecting the viewshed of the site. Highlight any viewshed management plans or other documents that discuss the current and expected impacts of normal development of the viewshed.
- Recreation venues in the vicinity of the site. Describe the type of venue, capacity, occupation rate and seasonal characteristics.
- Characteristics of distinctive communities (e.g., historic districts, tourist attractions, cultural resources, American Indian lands and resources, and other popular resources). Discuss any expected trends affecting these resources.

2.5 Environmental Justice

Environmental justice (EJ) refers to a Federal policy established by Executive Order 12898, “Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations” (59 *Federal Register* [FR] 7629) (Ref. 35), under which each Federal agency identifies and addresses, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority or low-income populations.³ Although it is not subject to the Executive Order, the Commission has voluntarily committed to undertake environmental justice reviews and issued its policy statement on the treatment of environmental justice matters in licensing actions (ML033380930). LIC-203, Revision 2, “Procedural Guidance for Preparing Environmental Justice Assessments and Considering Environmental Issues” provides the staff’s methodology for performing EJ analyses (Ref. 36).

The environmental justice review involves identifying minority and low-income populations in the vicinity of the plant that could experience disproportionately high and adverse health or environmental effects from building and operation of a new nuclear power plant. To assist the NRC staff in its review of potential human health or environmental effects that could occur, the applicant should identify:

- minority or low-income populations of interest, termed “EJ populations of interest,” that could be affected by building and operation of the proposed project; and
- pathways that could result in any disproportionately high and adverse human health or environmental effects to EJ populations of interest.

2.5.1 Identification of EJ Populations of Interest

The applicant should use the following process to identify and characterize the demographic region in terms of its minority and low-income populations and communities residing in a 50-mile radius (the demographic region). The principal steps in the process of identifying the EJ populations of interest include:

- A quantitative assessment of minority and low-income populations living in the demographic region, performed at the CBG level and a determination of whether or not the identified minority or low-income populations in the CBGs are of sufficient size to merit further investigation (i.e., “EJ populations of interest”). As described in the socioeconomics section, minority populations are defined by race as African American or Black, American Indian or Alaska Native, Asian, Native Hawaiian or other Pacific Islander, and by ethnicity as Hispanic, Latino or Spanish origin (of any race). Low-income populations refer to individuals or households meeting the official poverty definition (at or below the Federal poverty level) (LIC-203, Revision 3).

The NRC includes two additional minority or low-income groups in its analyses:

- Other Race (including subcategories of the races mentioned above) or Two or More Races
- Aggregate Minority (calculated as Total Population minus White (Not Hispanic or Latino)).

³ The USCB list of minority and ethnic categories and the definition of “low-income,” definition can be found at <http://ask.census.gov/>.

- Investigation of the demographic region to determine whether any potential minority or low-income populations that could be considered EJ populations of interest exist in the region and were overlooked during the quantitative assessment.
- Identification of communities with unique characteristics including migrant worker communities or minority or low-income elderly or home-bound communities.

Methodology and Analysis

Minority and low-income populations of interest can be identified in one of two ways. First, the NRC has established specific criteria (see LIC-203) to determine if any CBG meets an EJ threshold and be considered an EJ population of interest. An EJ population of interest should be examined more closely to determine whether or not an EJ impact exists. Those criteria are:

- Any CBG having a minority or low-income population with 50 percent or more of the total population in the CBG, or
- Any CBG having a minority or low-income population with a proportion 20 or more percentage points greater than the same minority or low-income proportion measured at the State level.

For example, if the State-level proportion of a minority or low-income population were 20 percent, to meet the minority or low-income population of interest threshold a specific CBG's minority, or low-income population proportion would need to be at least 40 percent. By the same criteria, if the State proportion of the population were 60 percent and the CBG's proportion were 52 percent, then the CBG would cross the 50 percent threshold and would be considered a minority or low-income population of interest, even though the proportion was not 20 percentage points greater than the State average.

Second, minority and low-income populations of interest may exist that are too small to be easily identified using the CBG approach. For example, the economic region may include a small, but highly concentrated minority population that is masked by a larger demographic within the population's block group. Consequently, identification of populations of interest at the CBG level is not sufficient by itself for the purposes of the EJ analysis. The existence of unique populations can be found through public outreach and field investigations in the demographic region to determine whether the CBG analysis missed any minority and low-income populations of interest.

Description in the ER

The applicant should describe their analysis and all public outreach and field investigations performed to develop the demographic data for the ER. The ER should also include the following information:

- A series of maps, one each for each important minority and low-income populations of interest, identifying the CBGs within the demographic region that meet either of the above population of interest criteria for minority or low-income populations. The maps should note the location of the proposed site, principal cities and towns, roads, and any other relevant features. The maps should indicate which, if any, CBGs trigger the EJ threshold proportion. Each map should be accompanied by a table containing a count of the CBGs within the demographic region that meet or exceed the comparative threshold criteria (see example Table 2-2 below).
- Discussion of the specific methods used to develop the maps and tables, including references to all data sources and literature cited and a discussion of the specific geospatial information system methods and data used.

- Discussion of minority or low-income migrant communities. Migrant communities refer to communities that may establish residence temporarily or seasonally, based on the availability of agricultural or construction work. For example, migrant agricultural workers may move in to local campgrounds or establish makeshift camps during particular harvest seasons. Migrant construction workers may do likewise during construction of a new subdivision or other substantial projects near the site.

Table 2-2. CBGs in the demographic region by EJ status

| State/ County | Total Census Block Groups | Number of Census Block Groups with Minority Populations | | | | | | | Number of Census Block Groups with Low- Income Populations |
|---|------------------------------------|--|---|-------|---|---------------|---|-----------|---|
| | | Black or African American | American Indian or Alaska Native | Asian | Native Hawaiian or other Pacific Islander | Other Race | Hispanic, Latino, or Spanish Origin | Aggregate | |
| | State 1 | | | | | | | | |
| County 1 | | | | | | | | | |
| County 2 | | | | | | | | | |
| County 3 | | | | | | | | | |
| | State 2 | | | | | | | | |
| County 4 | | | | | | | | | |
| County 5 | | | | | | | | | |
| Total | | | | | | | | | |
| Shaded rows indicate counties in the economic region. | | | | | | | | | |

2.5.2 Identification of Potential Pathways and Communities with Unique Characteristics

The applicant should identify any potential pathways that could result in disproportionately high and adverse human health or environmental effects to minority or low-income populations of interest.

Methodology and Analysis

Subsistence practices and communities with unique characteristics should be the focus of the analysis of potential pathways considered in the EJ analysis. The applicant should coordinate its EJ analysis with the historic and cultural resources analysis to identify any potential American Indian Tribal linkages to traditional or culturally important resources (e.g., culturally important activities, lands, or waters).

Subsistence

Subsistence refers to the activities of low-income communities, households, or individuals to acquire resources by nonmarket means such as home gardening, fishing, hunting, and gathering. Subsistence practices can accomplish the following:

- Provide direct income through sale of harvested resources (e.g., cord wood or mistletoe sales).
- Supplement household income by substituting wild or home produced foods for commercially purchased foods, freeing up available income to be applied to other expenses.
- Facilitate participation in a traditional ecologically-based American Indian lifestyle through the consumption of traditional animal or plant species or through activities on traditional lands.

The existence of specific subsistence and related resource dependencies attributable to any site are most commonly documented by direct observation and interviews with local minority and low-income community leaders. The applicant should determine whether any EJ communities in close proximity to the site or proposed offsite facilities, exhibit these practices. Outreach activities should provide a basis for identifying whether such activities may be present near the site.

EJ Communities with Unique Characteristics

For the purposes of NRC environmental reviews, “unique EJ communities” refers to traditional, cultural or religious communities with specific ties to the lands or waters near the site. For example, American Indian Tribes may have specific rights or a cultural or spiritual attachment to natural resources at a site (e.g., wild rice, sweet grasses, and other traditional medicines). However, unique EJ community characteristics can also be physical, such as local community access routes that facilitate a community’s ability to function normally.⁴ Low-income communities with unique characteristics may be found in areas of low-income housing (private or federally subsidized). The nature of the unique characteristic of a low-income community may need to be determined by interviews and community visits. The applicant should remain sensitive to how project-related activities at the proposed plant could create pathways for a disproportionately high and adverse impact on such communities.

Description in the ER

The ER should contain the following:

⁴ For instance, in the case of Louisiana Energy Services (CLI-98-3, 47 NRC 77 (1998)) (Ref. 37), the planned closure of a small rural road would have prevented the north-south movement of a local African-American community to and from their local church. And in the case of the V.C. Summer new reactor combined license (Ref. 38), traffic during commute times was found to impede local low-income foot traffic that served the local community’s most used route to market.

- Discussion highlighting the methods used to identify EJ-related practices or resources described above.
- Description of any potential pathways that could result in disproportionately high and adverse impacts to minority or low-income populations that would require further analysis in Chapters 4 and 5.

2.6 Historic and Cultural Resources

Historic and cultural resources are the remains of past human activities and include prehistoric and historic era archaeological sites, historic districts, and buildings, as well as any site structure or object that may be considered eligible for listing on the National Register of Historic Places (NRHP). Historic and cultural resources also include traditional cultural properties important to a living community of people for maintaining their culture. A historic property is a historic or cultural resource that is eligible for listing on the NRHP.⁵

National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.), requires Federal agencies to take into account the potential effects of their actions on the cultural environment. The National Historic Preservation Act of 1966 (NHPA) (54 U.S.C. 300101 et seq.) requires Federal agencies to consider the impacts of their undertakings on historic properties if they are eligible, or considered potentially eligible for listing in the NRHP.

The applicant should use Section 106 of the NHPA, and implementing regulations at 36 CFR Part 800, “Protection of Historic Properties” (Ref. 40), as a guide for providing historic and cultural resource information in the ER. In accordance with 36 CFR Part 800, an applicant should conduct informal consultation (i.e., information gathering) for the purposes of gathering information with the State Historic Preservation Officer (SHPO), affected American Indian Tribes, and interested parties before determining the boundaries of the proposed area of potential effects (APE) to be recommended to the NRC. Once the proposed APE has been determined, the applicant should conduct cultural resource investigations to identify historic and cultural resources located within the APE, determine if they are eligible for listing on the NRHP, assess affects, and develop avoidance or mitigation plans to resolve adverse effects. The NRC will use this information to support its Section 106 consultation and assessment of effects for the proposed project.

The NRC typically defines the APE as the area or areas at the power plant site and the immediate environs that may be directly or indirectly impacted by building and operating the proposed new unit(s). The applicant should describe the proposed project area and provide the following information in the ER:

- A U.S. Geological Survey Quadrangle map that identifies the APE (e.g., direct [physical] or indirect [visual, auditory, atmospheric such as fugitive dust, light, and traffic]).⁶

⁵ As defined in 36 CFR 800.16(l)(1), “Historic property means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places maintained by the Secretary of Interior. This term includes artifacts, records, and remains that are related to and located within such properties.” As defined in 36 CFR 800.16(l)(2), “The term eligible for inclusion in the National Register includes both properties formally determined as such in accordance with regulations of the Secretary of the Interior and all other properties that meet National Register listing criteria.” National Register criteria for listing are found in 36 CFR Part 60 (Ref. 39), “National Register of Historic Places.”

⁶ As defined in 36 CFR 800.16(d), “Area of potential effects means the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking.”

- Legal description of the APE appropriate for the proposed project area. Note that not all areas of the U.S. (i.e., the original 13 colonies) use the Public Land Survey System (e.g., township, range, and section information).
- Aerial photos of the proposed project site before any land disturbing activities commence.
- Identification of any parts of the APE that are Federal, State, or Tribal-owned (i.e., not privately owned) lands.

2.6.1 Cultural Background

This section of the ER should provide a discussion of the historic use of the land and the activities that have occurred within APE and the surrounding area. This includes a description of the cultural history of the region (including the proposed project site) from the beginning of human settlement to the present, and summarizes how this information was collected for the proposed APE. Information can be derived from background research (literature review and site file search) and from the use of plat and other historic maps showing ownership, acreage, property boundaries, and the location of existing or former historic structures. Other sources that can assist with description of the cultural background include land records, archival sources, local museums or historical societies, libraries, planning documents, mapping/imaging, and online sources. If available, consult ethnohistoric sources to identify affected American Indian Tribes and other groups that may have historic and cultural ties to the proposed project area.

2.6.2 Historic and Cultural Resources at the Site and in the Vicinity

This section of the ER should provide a description of historic and cultural resources identified within the direct and indirect APEs (e.g., transmission line corridors, and in the vicinity). All cultural resource survey reports that are developed to identify and assess effects to historic and cultural resources should be referenced and submitted with the license application. However, information (i.e., reports, maps, and site forms) that discloses the locations of unevaluated, potentially eligible, or eligible historic properties (e.g., archaeological sites) should be withheld from public disclosure. This information may be protected under NHPA Section 304 (54 U.S.C. 100707), especially if there is a risk of harm to the resource. The NRC protects cultural resource information disclosing the location of cultural resources (e.g., maps) under Section 304 of the NHPA, consistent with 10 CFR 2.390(a)(3). Section 304 of NHPA requires the NRC to “withhold from disclosure to the public, information about the location, character, or ownership of a historic resource if the agency and the Secretary of the Interior agree that disclosure may (1) cause a significant invasion of privacy, (2) risk harm to the historic resource, or (3) impede the use of a traditional religious site by practitioners.” Discuss with the staff during pre-application interactions how to handle sensitive historic information.

The applicant should rely on qualified professionals who meet the Secretary of Interior’s standards, 36 CFR Part 61, “Professional Qualification Standards” (Ref. 41), to develop the historic and cultural resource sections in the ER. The applicant is encouraged to engage the NRC staff as early as possible in the planning process, in accordance with 10 CFR 51.40, “Consultation with NRC staff,” to avoid issues related to disclosing sensitive location information related to historic and cultural resources when drafting the ER.

The ER should provide the following information:

- description of all past and current fieldwork conducted (e.g., Phase I, II, and III) to identify historic and cultural resources within and surrounding the APE

- documentation of field methods used to identify resources within the APE, as required by 36 CFR 800.4
- description of all historic and cultural resources, (e.g., prehistoric and historic archaeological sites, standing structures, cemeteries, and traditional cultural properties), and isolated finds and features
- evaluation of historic and cultural resources for NRHP eligibility (i.e., historic properties) including:
 - description of the process and methods used to evaluate these resources
 - documentation of SHPO and affected American Indian Tribes concurrence with process, methods, and conclusions

2.6.3 Consultation

The ER should contain a summary of informal consultation efforts to date, including the process used to identify affected American Indian Tribes and potential interested parties about the proposed project. In consultation with the SHPO and affected American Indian Tribes, the applicant should evaluate the significance of the historic and cultural resources and assess any effects the proposed project may have on them. For areas not surveyed (e.g., areas too disturbed or devoid of potential historic and cultural resources), proper documentation, a basis for exclusion, and concurrence from the SHPO should be provided.

The ER should contain copies of all correspondence with the SHPO, affected American Indian Tribes, or members of the public whom the applicant consulted with to gather information about historic and cultural resources within the APE. These documents should be included in an Appendix of the ER. For reference on consultation with SHPOs, Advisory Council on Historic Preservation, affected American Indian Tribes, and the importance of early coordination, refer to NEI 10-07.

2.7 Air Resources

The applicant should describe the climate, meteorology, and air quality of the site and surrounding region, summarize atmospheric dispersion characteristics at the site, and provide details of the onsite meteorological monitoring program.

2.7.1 Climate

The applicant should provide a description of the regional climate and meteorological conditions at the site and include sufficient data to permit an independent evaluation by the NRC staff as outlined in NUREG-1555. The following information should be provided:

- Discussion of the sources of climate and meteorological information (e.g., nearby National Weather Service stations and onsite meteorological stations), periods of record, station locations, and station representativeness.
- A description of the general climate of the region with respect to types of air masses, synoptic features (e.g., high- and low-pressure systems and frontal systems and principal storm tracks), general airflow patterns, temperature and humidity characteristics, precipitation, and any mesoscale circulations (e.g., valley flow and land-sea/lake breeze).
- Description of topographic features in the immediate vicinity of the onsite meteorological tower and within a 50-mi radius of the proposed plant, including any modifications attributable to the proposed plant that could influence meteorological instrumentation.

- Summaries of onsite monthly and annual wind roses and comparisons to nearby representative stations using the wind speed classes defined of RG 1.23, “Meteorological Monitoring Programs for Nuclear Power Plants” (Ref. 42), for a consecutive 24-month period of data that is not older than 10 years from the date of the application (and preferably three or more years of data if available).
- Summaries of onsite diurnal, monthly, and annual air temperatures and comparisons to climatic averages and extremes.
- Summaries of onsite diurnal, monthly, and annual dewpoint temperatures and humidity and comparisons to climatic averages and extremes.
- Summaries of onsite monthly and annual precipitation and snowfall amounts and comparisons to climatic averages and extremes.
- Summaries of monthly and annual occurrences of heavy fog (i.e., visibility less than 0.4 km (0.25 mi)) and appropriate summaries of other parameters (e.g., icing) to support the description of cooling-system impacts.
- Summaries of onsite monthly and annual atmospheric stability.
- Annual joint frequency distributions of wind speed and wind direction by atmospheric stability class for measurement heights and wind speed classes as defined in RG 1.23.
- Estimates of monthly and seasonal mixing-heights, including frequency and duration (persistence) of inversion conditions.
- A description of the severe weather phenomena (e.g., hurricanes, tornadoes and waterspouts, thunderstorms, severe wind events, lightning, and hail) affecting the site and vicinity, including seasonal and annual frequencies.
- Discussion of potential climate change in the vicinity of the site over the period encompassing the licensing action and impacts on relevant meteorological parameters (e.g., temperature, precipitation, and the frequency and severity of storms). This discussion should be based on assessments conducted by Federal agencies with a mandate to evaluate the effects of climate change (e.g., latest U.S. Global Change Research Program Report), but applicable regional and local studies conducted by other entities may be included.

2.7.2 Air Quality

The applicant should describe the air quality at the site and surrounding region and provide sufficient detail to evaluate impacts from building and operating the plant. The following information should be provided:

- A description of the site and regional air quality, including the Air Quality Control Region as listed in 40 CFR Part 81, “Designation of Areas for Air Quality Planning Purposes” (Ref. 43).
- Identification of any nonattainment or maintenance areas with respect to criteria air pollutants identified in 40 CFR Part 50, “National Primary and Secondary Ambient Air Quality Standards” (Ref. 44).
- Location of nearest Mandatory Federal Class 1 Areas (40 CFR Part 81), where air quality and visibility are protected under the Regional Haze Program.

- Discussion of greenhouse gases (GHGs) and estimates of yearly emissions (expressed in units of CO₂ equivalents⁷) at a global, national, and state level and, if available, provide State or Public Utility Commission GHG emission reduction goals. This discussion should be based on values provided by Federal agencies with a mandate to estimate GHG emissions and is needed to provide context for GHG emissions from the proposed project (See Attachment 1 to COL/ESP-ISG-26, “Attachment 1: Staff Guidance for Greenhouse Gas and Climate Change Impacts for New Reactor Environmental Impact Statements” (Ref. 45)).

2.7.3 Atmospheric Dispersion

The applicant should provide short-term dispersion estimates for use in evaluation of dose from design-basis accidents and long-term dispersion and deposition estimates for evaluation of radiological impacts from normal operations. The applicant should provide meteorological data from at least two consecutive annual cycles (and preferably three or more entire years), including the most recent one-year period, at the time of application submittal. If two years of onsite data are not available at the time the application is submitted, the applicant should provide at least one annual cycle of meteorological data collected onsite with the application. Hourly averages of onsite meteorological parameters should be provided using the recommended electronic data format described in Appendix A of the most current revision of RG 1.23. Sufficient input data should be included to permit independent evaluations and assessments of atmospheric diffusion characteristics and station impacts on the environment as outlined in NUREG-1555.

Short-Term Dispersion Estimates

The applicant should provide estimates of atmospheric dispersion factors (χ/Q values) at the site exclusion area boundary (EAB) and at the outer boundary of the low-population zone (LPZ) for appropriate time periods using realistic (50th percentile) meteorology. For the EAB, provide the 2-hour 50th percentile χ/Q estimate. For the LPZ, provide the 50th percentile χ/Q estimate for: (1) the 8-hour time period from 0 to 8 hours; (2) the 16-hour period from 8 to 24 hours; (3) the 3-day period from 1 to 4 days; and (4) the 26-day period from 4 to 30 days.

Regulatory Guide 1.145, “Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants” (Ref. 46), provides guidance for calculating EAB and LPZ atmospheric dispersion factors. The applicant should adequately describe the methods for generating these distributions. Discussion of the effects of topography and nearby bodies of water on short-term dispersion estimates should be provided. The meteorological data used as input to the models should be provided.

Long-Term Dispersion Estimates

The applicant should provide estimates of annual average atmospheric dispersion (χ/Q) and deposition (D/Q) at appropriate locations (e.g., site boundary, nearest vegetable garden, nearest residence, nearest milk animal, and nearest meat cow in each 22½-degree direction sector within a 5-mi radius of the site), at points of maximum individual exposure, and at points within a radial grid of sixteen 22½-degree sectors (e.g., centered on true north, north-northeast, northeast) and extending to a distance of 50 mi from

⁷ Carbon dioxide (CO₂) equivalents is a metric used to compare the emissions of GHG based on their global warming potential (GWP). GWP is the total energy that a gas absorbs over a period of time, compared to carbon dioxide. Carbon dioxide equivalent is obtained by multiplying the amount of the GHG by the associated GWP.

the station. A set of data points should be located within each sector at increments of 0.25 mi out to a distance of 1 mi from the plant, at increments of 0.5 mi from a distance of 1 to 5 mi, at increments of 2.5 mi from a distance of 5 to 10 mi, and at increments of 5 mi thereafter to a distance of 50 mi. Estimates of χ/Q (undecayed and undepleted; depleted for radioiodines) and D/Q radioiodines and particulates should be provided at each of these grid points.

Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors" (Ref. 47), presents criteria for characterizing atmospheric dispersion and deposition conditions for evaluating the consequences of routine releases. The applicant should describe the methods for generating these χ/Q and D/Q values. The applicant should provide a detailed description of the model inputs, including the suitability of input parameters, source configuration, and topography. The meteorological data used as input to the models should be provided.

2.7.4 Meteorological Monitoring

The applicant should describe the preoperational and operational programs for meteorological measurements at the site, including all data-collection programs used to describe the site meteorological and atmospheric dispersion characteristics. The description should include the following:

- A site map showing tower locations with respect to man-made structures, topographic features, and other site features that may influence site meteorological measurements.
- Distances to nearby obstructions of the flow in each downwind sector.
- Discussion of measurements made; instruments and performance specifications; measurement elevations and instrument siting; calibration and maintenance procedures; data output and recording systems and locations; and data processing, archiving, and analysis procedures.
- Estimates of overall system accuracy for each meteorological parameter measured.

Regulatory Guide 1.23 provides guidance for an onsite meteorological measurements program that the NRC staff considers acceptable for the collection of basic meteorological data needed to support plant licensing and operation.

2.8 Nonradiological Health

The applicant should describe the environment at the site and within the vicinity of the site with respect to existing nonradiological human-health. This includes the identification of people or groups that could be vulnerable to nonradiological health impacts including public health, etiological agents, transportation activities, noise and electromagnetic fields. This section provides the basis for evaluation of impacts on human health from building and operating the proposed project.

2.8.1 Public and Occupational Health

The applicant should identify the State agency or office or Federal agency with regulatory jurisdiction over the public and occupational health at the site and in the vicinity. The applicant should provide the following information in the ER:

- Description of the regulations related to potential impacts on public and occupational health at the site and in the vicinity,

- Identification of people or groups in the vicinity that could be vulnerable to nonradiological health impacts from building- and operations-related activities (e.g., construction workers, workers at any co-located plants, nearby residents, transients and recreational visitors).

Occupational Injuries

- A discussion of Federal and State statistics for occupational injuries and illnesses related to similar projects. Federal statistics are available from the U.S. Bureau of Labor Statistics.
- A description of existing safety standards, practices, and mitigation procedures for avoiding or minimizing the incidence of injuries and illnesses to workers and the public.

Etiological Agents and Emerging Contaminants

Etiological agents are disease-causing organisms that affect human health. Some of these disease-causing organisms have been associated with the operation of station cooling systems. Etiological agents have been referred to as “thermophilic microorganisms” in previous NRC documents (e.g., NUREG-1555). Etiological agents associated with nuclear power stations include more than just thermophilic microorganisms and may be present in elevated numbers in unheated systems as well as in cooling systems, receiving and source waterbodies, and site sewage treatment facilities.

Contaminants and materials are being discovered in water that previously had not been detected or are being detected at levels that may be significantly different than expected. The proposed use of reclaimed water or from impaired water sources for station cooling raises a potential human health and ecological concern related to the release of these chemicals and materials to the environment. These chemicals or materials found in reclaimed and contaminated source water in very low concentrations that potentially could be harmful to humans and the environment.

The applicant should provide the following information:

- A description and the incidence of organisms of concern for public and occupational health, including enteric pathogens (e.g., *Salmonella* spp. and *Pseudomonas aeruginosa*), thermophilic fungi, bacteria (e.g., *Legionella* spp. and *Vibrio* spp.), dinoflagellates (*Karenia brevis*), blue-green algae, and free-living amoeba (e.g., *Naegleria fowleri* and *Acanthamoeba* spp.) during the previous ten years in the State that the site is located.
- Characteristics of the site that could encourage the growth and distribution of etiological agents.
- A summary of all the chemicals and materials that are known from the influent for stations using reclaimed water or impaired water for cooling.
- The ER should reference information from the U.S. Centers for Disease Control and Prevention, State public health agencies, and local health agencies.

2.8.2 Noise

The applicant should characterize the existing noise environment at the site. The description should include the following:

- General description of the site with respect to noise (e.g., rural, industrial, etc.).
- Results of any ambient noise studies that have been conducted, including the locations of noise sources and measurements, and corresponding noise levels, including meteorological conditions during the measurement period and the resulting effects on the measured noise levels.
- Location of the closest noise-sensitive human receptors.

- Noise regulations or ordinances, including Federal, State, and local code and regulations.

2.8.3 Transportation

The applicant should describe the existing transportation networks for the site, vicinity and region. The description should include the following:

- A summary of the regional and local highway, rail, and/or barge transportation networks as described in the land use and socioeconomic sections.
- Current accident statistics for the regional transportation networks.

2.8.4 Electromagnetic Fields

The applicant should provide information about the existing sources of electromagnetic fields in the vicinity and region and the acute and chronic effects of transmission lines. The information provided in the ER should include the following:

- Electric and magnetic fields for existing or anticipated transmission lines. In the United States, transmission lines operate at a frequency of 60 Hz (60 cycles per second), which is considered to be extremely low frequency.
- Acute effects from exposure to energized conductors or from induced charges in metallic structures.
- Effects of long-term or chronic exposure to electromagnetic fields. These health effects have been studied for several years and were evaluated in NUREG-1437, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” Initial (Ref. 48), and Revision 1 (Ref. 49), (License Renewal GEIS).

2.9 Radiological Environment and Radiological Monitoring

The purpose of a radiological environmental monitoring program (REMP) is to provide a basis for evaluating concentrations of radioactive materials and radiation levels in the environment from radiological releases once a reactor is operational. A well-designed and well-implemented environmental program will characterize the environment before operations to allow future reasonable, direct comparison with data collected after power operation begins. The preoperational program can also be used for all or some of the operational REMP.

According to RG 4.1, “Radiological Environmental Monitoring for Nuclear Power Plants” (Ref. 50), the preoperational monitoring program is not required to be implemented until two years before plant operation; however, the preoperational REMP should be described in the ER.

For a greenfield site, the applicant should summarize any information available from the literature about background radiological characteristics of the site. This characterization should address the sources of natural background and the background radiation levels from those sources in the area surrounding the site. The naturally occurring background radiation dose rates at the site should be estimated and provided in the ER.

For a proposed new nuclear unit being constructed on or adjacent to currently operating or permanently shutdown nuclear plants, information on background radiological characteristics should be provided from the annual “Radioactive Effluent Release and Radiological Environmental Operating Report.” The applicant should review approximately five years’ worth of data from the past reports and

make a comparison of the exposures and concentrations in air, water, and vegetation between the preoperational monitoring and the operational monitoring results. In addition, any special reporting requirements or special monitoring programs (e.g., groundwater-monitoring programs), whether industry- or NRC-initiated programs, and any event reports for groundwater contamination should be noted in the ER.

The type of data and information needed will be affected by site- and station-specific factors, and the degree of detail should be modified according to the anticipated magnitude of the potential radiological impacts of the radioactive effluents from the plant. The specific criteria for a radiological monitoring program can be found in RG 4.1.

To the extent the information is available, the ER should include the following information:

- A discussion of the environmental exposure pathways (i.e., air, water, and direct) as they relate to the type of reactor and local geography and terrain.
- A map or aerial photograph of the site vicinity with proposed monitoring and sampling locations clearly identified and keyed to indicate the medium sampled at each location. The map or photograph should be suitable to show distance and direction of each location from the plant, particularly with regard to the effluent release points.
- A description of the existing monitoring program when appropriate, including (1) the number and location of sample collection points and measuring devices and the pathway sampled or measured; (2) sample size, sample collection frequency, and sampling duration; (3) type and frequency of analysis; (4) general types of sample collection and measuring equipment; (5) lower limit of detection for each analysis; (6) the approximate date on which the proposed program will be effective; and (7) the quality-assurance program for REMPs (see RG 4.15, “Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination)—Effluent Streams and the Environment” (Ref. 51)).
- A discussion justifying the choice of sample sites, analyses, sampling frequencies, sampling and measuring durations, sample sizes, and lower limits of detection.
- If applicable, a description of NEI 07-07 “Industry Ground Water Protection Initiative” implementation (Ref. 52).
- A description of any NRC initiatives or radiological environmental reporting requirements.

Chapter 3

3.0 Site Layout and Project Description

As specified in 10 CFR 51.45(b), the environmental report (ER) “shall contain a description of the proposed action.” The ER should include sufficient information to describe the site layout, design, and the activities required to construct and operate the plant and associated structures and facilities as well as the physical activities involved in constructing and operating the plant. This description should be sufficiently detailed to support the staff’s environmental impact conclusions.

3.1 External Appearance and Plant Layout

A description of the overall appearance of the proposed plant and all associated facilities is needed to assess the physical scope of the proposed project and visual impacts. Associated facilities include any proposed new structures or structure modifications (onsite or offsite) that need to be completed for the proposed plant to be constructed or operated (e.g., transmission lines; road, rail, barge, or other transportation-related improvements; water-management structures or impoundments; borrow pits; and spoils storage areas).

The applicant should clearly define and use consistent site terminology (e.g., “site,” “property,” or “project” boundaries) throughout the ER. The ER should include the following information relating to the external appearance and layout of the proposed plant:

- topographic maps of the proposed site and vicinity showing the layout of the proposed plant relative to the site and vicinity; the exclusion area; site boundary; waterbodies; existing and planned roads, rail lines, and utility corridors; liquid and gaseous release points (and their elevations); meteorological towers; land to be cleared; waste disposal areas; and other buildings and structures (both temporary and permanent) associated with the proposed project;
- the relationship between the proposed plant and any existing units, structures or facilities, including removal or modification of existing structures;
- whether proposed and existing units would share any proposed or existing facilities or structures;
- a description of the proposed plant including any aesthetic principles and concepts used in the design and layout of the proposed facilities, and any plans to seclude and screen the facilities and to architecturally integrate the buildings and landscaping into the environs;
- representative ground-level photographs of the site on which major station features are superimposed;
- a low, oblique aerial photograph of the site and vicinity on which major station features are superimposed; and
- an architectural rendering of the proposed project to include landscaping and all major station features.

3.2 Proposed Plant Structures, Systems and Components

A description of the overall proposed nuclear energy generating system is important for the evaluation of environmental impacts resulting from the proposed project. The rated and design core thermal power, the rated and design gross electrical output, and the rated and design net electrical output (in megawatts [MW]) should be stated. The rated power is defined as the power level at which each reactor would be operated if licensed, and the design power is defined as the highest power level that

would be permitted by the proposed plant design. The gross electrical output is the power level measured at the output terminals of the generator and expressed in MW(e). The net unit electrical output is equal to the gross electrical output minus the nominal service and auxiliary loads. The following information relating to the reactor-power-conversion system for the proposed plant should be included in the ER:

- Reactor-power-conversion system, including the manufacturer and the design status (i.e., certified design or design control document revision).
- The number of units and description of each reactor, including (as applicable) reactor type, vendor, architect-engineer, contractor, fuel assembly description, total quantities of uranium, and percentage uranium-235 enrichment.
- The planned average irradiation level of spent fuel, in megawatt days/ton.
- A description of the turbines and condensers.
- A simplified flow diagram for the reactor-power-conversion system.
- Service or auxiliary power load.
- Type of cooling system.

A description of all proposed plant structures, systems, or components is needed to clarify the physical scope of the proposed project for assessing the impacts of building and operation. The description should include, but is not limited to the following:

- Plant grade and major structure elevations, using a consistent vertical datum.
- Stormwater drainage system (e.g., number, location, and size of temporary and permanent retention/detention ponds, diversion structures, or other hydrological alterations).
- Site layout with the location and dimensions (e.g., area and height above grade) of structures and support facilities (e.g., switchyard, laydown areas, parking areas, future independent spent fuel storage installation, warehouses, and training facilities), including offsite support facilities and substations. Indicate permanent and temporary areas of land disturbance.
- Heat-dissipation system flow diagram; design, size, and location of cooling towers, cooling lakes or ponds, spray canals or ponds.
- Creation or modification of any water storage (reservoir) or cooling pond, including dams or dikes. For any water-storage facility, describe the total and usable storage capacity, surface area, evaporation rate, flow control structures or components, and associated water transfer systems (e.g., refill, withdrawal and conveyance).
- Water-intake systems, including plan view and cross-sectional view scale drawings. The description should include location, size, height, and depth of structure; number and size of intake bays and pumps; screen types and sizes; type of screen cleaning system; fish-return system; and associated pipelines or other conveyance structures.
- Water discharge system, including plan view and cross-sectional view scale drawings. The description should include the location and type of discharge structure(s) including depth below surface and relationship to bottom of receiving waterbody; discharge receiving area alterations; and associated pipelines or other conveyance structures.
- Other water systems (e.g., service, fire, potable, and sanitary systems) with source, delivery, and discharge (if applicable) identified.

- Well structures (use, depth, diameter, construction, location, pumping rate or discharge rate for injection wells).
- Supplemental water sources, onsite or offsite (location, design, construction and management).
- Transportation infrastructure (e.g., location, extent, and number of roads, culverts, bridges, rail, barge slip, and barge facilities).
- Other in- or over-water structures.
- Transmission (e.g., location, extent, voltage, and number of existing transmission facilities, modifications to existing transmission facilities, use or modification of existing transmission corridors, new transmission corridors, new transmission lines, transmission structure types, and switchyards).

3.3 Building Activities

Building activities, methods, and durations influence the environmental impacts of the proposed project. The applicant should describe the type of activities needed to build or install the proposed structures and associated facilities described in Section 3.2, and should indicate the sequencing and estimated duration of activities, especially when multiple units are proposed. The ER should include consideration of seasonal constraints on building activity. If multiple units are proposed or if the proposed project is co-located with an existing facility, the ER should include consideration of activities and workforce related to concurrent building and operation.

The description of building activities in the ER should also include the following:

- Applicants should be prepared to provide spatial data in electronic format (current industry-standard format) for the proposed plant (permanent as-built structures) and associated building uses (including temporary structures and use areas).
- Maps or scale drawings showing the extent of area to be disturbed during building (both onsite and offsite) and the construction use of the site or project areas (e.g., laydown, spoils stockpile or disposal, concrete batch plant, module assembly, temporary roads, or parking) relative to the as-built proposed structure locations.
- Extent, equipment, and methods for land clearing, grading, and excavation.
- Depths of excavations, particularly deep excavations that could require dewatering; and width and depth of trenches (e.g., for pipelines).
- In-water and nearshore activities (e.g., dredging, excavation, dewatering, filling, and impoundments).
- Equipment and methods should be described, as well as extent and duration of shoreline and in-water disturbance and any temporary structures (e.g., cofferdams, barge moorings, and silt curtains).

- Source of water for building purposes, estimated rate and quantity of water use, and proposed wastewater-management practices for building activities.
- Source and quantity of fill material for construction purposes.

3.4 Operational Activities

The applicant should describe the type of activities involved in operating the proposed plant and the associated structures and facilities described in Section 3.2. Descriptions should provide sufficient detail to assess specific effects of all operating systems on the environment. All modes of operation should be described, including normal operation, refueling, and emergency shutdown situations. Seasonal and operational variations that change amounts of water intake or discharge, gaseous effluent releases, or other potential environmental releases should be discussed.

3.4.1 Plant-Environment Interfaces during Operation

The applicant should describe plant design and heat-dissipation system parameters and their associated site interface values, clearly indicating the units of measure for the interface value and whether the value is for a single unit or all proposed units. The applicant should also describe the operational activities for structures and facilities associated with the transmission system, transportation infrastructure, and the stormwater-management system. Information on operational environmental interfaces should include, but is not limited to, the following:

- Water Interfaces
 - A quantitative water-use diagram showing anticipated flow rates to and from the various station water systems (e.g., heat-dissipation system, sanitary system, radwaste and chemical waste systems, and process water systems), including the source of water for each system and the receiving water for any liquid discharge to a waterbody.
 - A table of anticipated normal operational flow rates and maximum flow rates, indicating assumptions and conditions for each.
 - The flow diagram and tabulated information that clearly presents the operating plant water balance by accounting for withdrawals, consumptive use (water that is not returned to the source water body, for example, water from a river that is lost to evaporation in the cooling towers), and liquid discharges.
 - A description of intake operation, including approach and through-screen velocities, debris, and fish-return-system operation at all intake or pumping locations.
 - Pertinent temperatures and methods used for estimating evaporation and drift rates.
 - Cooling-tower blowdown volume, flow rates, temperature range, and number of cycles of concentration assumed for normal operation and any other modes of operation considered.
 - Estimated temperature and chemical constituent concentrations in wastewater at the discharge point.
 - A description of controlling structures and flow patterns, residence times, rate of temperature changes, evaporation rate, and seepage rate for any cooling-water reservoirs or discharge canals.
 - Maintenance procedures and frequency for the intake and discharge structures (e.g., dredging or mucking, biofouling treatment, screen maintenance, and pump maintenance), including proposed waste- or debris-disposal practices.

- Maintenance procedures and frequency for the stormwater-management system, including proposed waste- or debris-disposal practices.
- Land Interfaces
 - Maintenance procedures and frequency for transmission corridors and switchyards, roads, parking areas, rail lines, and other infrastructure, including proposed waste- or debris-disposal practices.
- Air Interfaces
 - Location, including elevation, of plant vents and other exhaust vents. The number and capacity of diesel/turbine generators and other emission sources, estimated frequency of operation, and associated emissions.

3.4.2 Radioactive Waste Management

Radioactive waste-management and effluent-control systems should be designed so as to control and maintain the radioactive material released annually in liquid and gaseous effluents from normal operation, including anticipated operational occurrences, to a level that is as low as is reasonably achievable in accordance with the requirement of 10 CFR 50.34a, “Design Objectives For Equipment To Control Releases of Radioactive Material in Effluents-Nuclear Power Reactors.” The information should be taken from the final safety analysis report (FSAR) and summarized in the ER. References to the FSAR sections should be made in the ER. The following information relating to the radioactive waste-management system should be included in the ER:

- a summary description of the liquid and gaseous radioactive waste-management and effluent-control systems;
- process and instrumentation diagrams and system process flow diagrams of the liquid and gaseous radioactive waste-management and effluent-control systems referenced from the FSAR;
- identification of sources of radioactive liquid and gaseous waste material within the proposed plant;
- identification of principal release points for radioactive materials to the environment;
- elevation of gaseous effluent vents;
- identification of direct radiation sources stored onsite as solid waste (e.g., an independent spent fuel storage installation or permanently shutdown units on the site);
- information requested in Appendices A and B of RG 1.112, “Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Nuclear Power Reactors” (Ref. 53);
- a summary description of the solid radioactive waste-management system to include the expected total volume of the solid radioactive waste that would be shipped offsite annually;
- solid radioactive waste storage plans and capabilities, including annual quantities of waste produced;
- a discussion on where the Class A, B, and C low-level waste will be sent;
- description of plant systems producing mixed waste (hazardous and low-level radioactive), and minimization plans;
- mixed-waste storage plans and capabilities, including annual quantities of waste produced; and

- mixed-waste disposal plans.

3.4.3 Nonradioactive Waste Management

The applicant should describe any nonradioactive solid or liquid-waste materials such as water-management waste, solid waste, gaseous waste, and hazardous waste that may be generated during operation. The description should include estimates of the quantities of wastes to be disposed of, their pollutant concentrations, the manner in which they will be treated and controlled and the procedures for disposal. The information related to these waste systems for the proposed plant should include, but are not limited to the following:

- description of liquid effluents, including treatment, characteristics, rate and frequency of release,
- for effluents containing chemicals or biocides, a list of chemicals, annual amounts used, frequency of use, and concentration in waste stream,
- sanitary effluent discharges, treatment, and disposal,
- estimates for quantities of solid waste, collection, and disposal,
- location and elevation of gaseous effluent vents,
- description of gaseous effluents, including treatment, characteristics, quantity and frequency of release; and
- hazardous waste accumulation, treatment, and disposal.

Chapter 4

4.0 Environmental Impacts from Construction of the Proposed Project

The applicant should adequately describe the impacts of building the proposed project as specified in 10 CFR 51.45(b)(1) and 51.45(c). For each impact category in Chapter 4, the applicant should identify the measures and controls that would be used to mitigate and limit adverse environmental impacts. As discussed in Part B, where this chapter refers to “building” it includes all preconstruction and construction activities. As discussed previously, under the revised limited work authorization rule, the applicant should separate the impacts of preconstruction and construction activities to address the latter, as they are the activities being authorized. Additionally, the applicant should also describe the impacts associated with preconstruction activities, so they can be evaluated as part of the cumulative impacts related to the construction activities. Specific information to include in the environmental report (ER), as part of or in addition to the description of impacts, is covered in the following sections.

4.1 Land-Use

The applicant should describe the land- or ground-disturbing alterations of building activities and the resulting impacts on land and resource uses. All impacts should be quantified to the extent possible using acreage, volumetric, or chronological measures.

4.1.1 Onsite Impacts

The following information relating to the land-use impacts from building activities should be included in the ER:

- Land disturbance related to building activities on a short-term or long-term basis tabulated and summarized in terms of acreage of land area by activity (e.g., grading, excavation, trenching, dredging, borrow pits, and clearing vegetation).
- Disposition of spoils from excavation work or dredging including volumes of excavated or dredged material and ultimate disposition location by volume to onsite or offsite locations. Include the acreage required for spoils disposal.
- A summary of the proposed footprint of land disturbance (by acre) for permanent and temporary uses (e.g., power block, auxiliary buildings, cooling infrastructure, laydown areas, batch plants, parking, and administration).
- Impacts to any affected local or regional land-use or economic-development plans.
- Discussion of possible zoning conflicts.
- Disruption to ongoing natural resource management activities, including agricultural, forestry, and mineral extraction activities.
- Disruption to land- or water-resource access.
- Disruption to existing land uses or private land access at the site or vicinity caused by building activities.
- Characterization of raw material resource-extraction volumes associated with building activities (e.g., reservoir timber clearing and sand and gravel mining).

- Impacts to legislatively designated lands (e.g., prime farmland) or activities in designated coastal zones and a discussion on the status of any agency coordination or permitting undertaken regarding such lands.
- Impacts to floodplains and wetlands (can cross-reference other ER sections).⁸
- Maps depicting the locations of expected land-use impacts including footprints for temporary and permanent facilities.

4.1.2 Offsite Impacts

The following information relating to the land-use impacts of offsite building activities should be included in the ER:

- Characterization of land uses that will be altered by offsite development activities.
- A summary of the proposed footprint of land disturbance (by acre) for permanent and temporary uses (e.g., transmission towers, substations, intake structures, and pipelines).
- Resulting land-use classification conversions summarized by acreage.
- Impacts to any affected local or regional land-use or economic-development plans.
- Disruption to land- or water-resource access caused by offsite activities.
- Disruption to existing land uses at the site or vicinity caused by building activities (e.g., private land access for transmission tower erection).
- Maps depicting the locations of expected land-use impacts including footprints for temporary and permanent facilities.
- Discussion of possible effects on floodplains, wetlands, agriculture, forestry, and mineral extraction (can cross-reference other sections of ER where possible).

4.2 Water Resources (Surface Water and Groundwater)

The applicant should describe the hydrologic alterations associated with building activities and the resulting impacts on consumptive and nonconsumptive water use⁹ and on water quality. Water use and discharge of effluents during building are described as part of the site layout and plant description (Chapter 3).

4.2.1 Hydrologic Alterations

The applicant should identify and describe the building activities including site preparation, onsite activities and offsite activities that could result in hydrologic alterations at the site, within

⁸ Executive Order 11988 (Ref. 54), "Floodplain Management" was issued on May 24, 1977 to restore and preserve the natural and beneficial values served by floodplains. This Executive Order requires agencies to determine whether the proposed action will occur in a floodplain, to evaluate the potential effects of any actions that may take place in a floodplain, and to consider alternatives to avoid adverse effects and incompatible development in floodplains.

⁹ Consumptive water use reduces the available water supply. For instance, evaporation due to cooling-tower operation results in a transfer of water from the cooling system to the atmosphere, thereby reducing the volume of water in the water source. Nonconsumptive water use does not reduce the available water supply, rather it is discharged back into the river and is not consumed by the plant.

transmission corridors, and offsite within the region of interest (ROI) (see Chapter 2). The description should include analyses of the resulting hydrologic alterations and the physical effects of these alterations on water uses and users (quantity and quality); practices proposed to minimize hydrologic alterations having adverse impacts; and an assessment of compliance with the applicable Federal, State, regional, local, and affected American Indian Tribal standards and regulations.

Activities resulting in hydrological alterations that could affect water use and water quality may include, but are not limited to, the building of cofferdams and stormwater management and drainage systems, dredging operations, placement of fill material in the water, and the creation of shoreside facilities. Other examples include building of intake and discharge structures for cooling water or other purposes, straightening or deepening of a water channel, building in a floodplain, clearing and grading, excavation, and groundwater dewatering of excavations.

The ER should include a description of the following:

- modification of site drainage pattern;
- change in floodplain capacity, and expected changes in water levels and groundwater heads;
- effects of alterations on the quantity and availability of water within the ROI;
- effects of alterations to river discharge, including changes in the seasonal variation of flow, or groundwater discharge to wetlands;
- effects of effluent discharge on the water quality of the receiving waterbodies, including the effects of erosion and sediment transport;
- proposed actions to minimize the effects of the hydrologic alterations; and
- identification of applicable standards and regulations.

When a mathematical model is used to evaluate the effects of hydrologic alterations, the applicant should describe the conceptual basis for the model, including the rationale for eliminating plausible alternative conceptualizations, the assumptions used in developing the model, the range of applicability of the model, input data used, the basis for boundary conditions, parameter estimation and calibration procedures followed, and estimates of uncertainty in model forecasts. The applicant should provide sufficient data to permit staff evaluation of modeling results, including input files used to obtain the model results and a description of any post-modeling analyses used by the applicant.

4.2.2 Water-Use Impacts

The applicant should identify those water uses and water users (Chapter 2 of this RG) that are potentially affected by the changes in the quantity and/or availability of water resulting from hydrologic alterations during building. The applicant should evaluate the water-use impacts by quantifying the anticipated reduction in water availability for each water use and provide a description of the analyses performed to determine the impacts.

4.2.3 Water-Quality Impacts

The applicant should identify those water uses and water users (Chapter 2 of this RG) that are potentially affected by the changes in water quality resulting from hydrologic alterations during building. The applicant should evaluate the water-quality impacts by quantifying the anticipated reduction in use resulting from the changes in water quality and provide a description of the analyses performed to determine the impacts.

4.2.4 Water Monitoring

The overall plan for protection of waterbodies that may be affected by building activities should be discussed. A description of the proposed measures to ensure compliance with applicable water-quality and water-use standards and regulations should also be provided. When compliance involves monitoring, the monitoring program should be described in sufficient detail to justify the ability of the monitoring to provide timely and accurate information so that appropriate actions can be taken to limit building impacts.

4.3 Ecological Resources

This section addresses the information related to terrestrial, wetland and aquatic ecological impacts from building activities at the proposed site. The applicant should provide adequate details in the ER to fully determine the impacts to terrestrial and aquatic species and habitats as a result of building activities.

4.3.1 Terrestrial and Wetland Impacts

Impacts to terrestrial resources should be based on a conservatively estimated footprint of ground disturbance encompassing the plant and associated facilities. The estimated footprint should also account for temporary features such as laydown areas. Estimates of the footprint used in the ER should be conservative enough to characterize terrestrial impacts in a way not overwhelmed by future minor adjustments to the proposed site layout. Supplementary guidance on some of the more common environmental impact analyses capable of providing some of the information outlined below is available in the most recent version of RG 4.11.

Terrestrial Habitats

The ER should address the following potential effects on terrestrial habitats from building the proposed nuclear power plant:

- Proposed methods for land clearing and grubbing vegetation; temporary and permanent erosion, runoff, and sedimentation control; and dust suppression and construction best management practices (BMPs) that might be used.
- Overlays of the estimated footprint of disturbance on terrestrial habitat maps, with separate indications for permanent and temporary disturbance.
- Tables quantifying each terrestrial habitat type within the estimated footprint with separate quantifications for permanent and temporary impacts for the site and for each offsite corridor or parcel.
- Tables or text comparing estimated losses of each terrestrial habitat type against total extent in the vicinity and a discussion of the relative importance of habitat types lost based on functions (e.g., importance to wildlife).
- Description of any plans for restoration (e.g., grading, contouring, seeding, and planting) of temporarily disturbed terrestrial habitats and an estimate of the time required for restored habitats to regain pre-disturbance conditions and functionality.
- Determination of whether excavation or other site-preparation activities might substantially dewater wetlands or surface waterbodies (e.g., ponds, springs, and seepages) or alter surface drainage patterns in a way that might affect terrestrial biota and a discussion of possible impacts to affected habitats and wildlife.

Wetlands

Information on wetland impacts should be as consistent as possible with Federal, State, and local wetland permit applications, and possible discrepancies should be explained. Wetland permit applications are sometimes prepared subsequent to the ER; in such cases wetland impact data presented in the ER should be conservative enough to account for likely impact levels ultimately reported in permit applications. The ER should also include information on unregulated wetland impacts, including impacts to wetlands not under regulatory jurisdiction. The ER should include the following:

- Estimated disturbance footprint overlaid onto the wetland maps developed for Chapter 2.
- Tables estimating wetland impacts using a widely recognized wetland classification system (e.g., the National Wetlands Inventory). Separate data should be provided for each wetland classification and each category of impact (e.g., permanent fill, temporary fill, permanent dredging, and temporary dredging). Separate tables should also be provided for the site and for each offsite parcel or corridor.
- Discussion of wetland impacts and their effect on the functions and values of wetlands.
- Discussion of construction BMPs that may be used to protect wetlands (e.g., buffers, mats, seasonal work limitations, signage, barriers, special erosion, and sedimentation control methods).
- Discussion of applicable Federal, State, and local wetland permit requirements and status of the application(s).
- Discussion of anticipated wetland mitigation. If possible, provide a tabular comparison of possible wetland losses and mitigation gains using a common metric such as functional service units (preferred approach) or acreage.

Wildlife

Qualitative discussions of possible effects on terrestrial wildlife are generally sufficient for an ER. However, evaluations should be based on quantitatively estimated causal factors (e.g., noise levels, structure heights, and corridor widths). The ER should include a discussion of the following:

- Possible mortality or physical injury to wildlife, especially immobile or weakly mobile species or life stages (e.g., eggs and juvenile stages).
- Increased traffic from construction workers that might injure terrestrial wildlife. The proximity of traffic to habitat and possible routes of wildlife movement should be considered.
- Noise from building activities that could startle wildlife or alter behavior (e.g., feeding, sheltering, movement, and reproduction).
- Habitat losses or degradation that could reduce carrying capacity of habitats in the surrounding landscape.
- Habitat losses and fragmentation that may affect movement and migration of wildlife.
- Tall structures or equipment (e.g., cranes) that might injure birds and bats, considering height and proximity to migration routes and areas of wildlife concentration.

Important Species and Habitats

The ER should include discussions related to the effects of building the proposed project on important terrestrial species and habitats:

- The effects on each terrestrial species identified as important using the criteria in Table 2-1.
- The effects on future viability of Federal or State-listed endangered, threatened, or special status species.
- Any relevant correspondence that has been initiated with the U.S. Fish and Wildlife Service (FWS), or State, local, or Tribal natural resource agencies about endangered, threatened, or other special status species and habitats. The ER should briefly summarize and provide copies of key correspondence (e.g., letters, e-mails, or phone call summaries).
- Cross references to the aquatic ecology section below may be appropriate for important species using both terrestrial and aquatic habitats (e.g., some waterfowl).

4.3.2 Aquatic Impacts

This section addresses the information related to aquatic ecological impacts from building activities at the proposed site. Applicants should consider the important aquatic species and habitat identified in Chapter 2 that may be affected by the proposed project. Supplementary guidance on some of the more common environmental impact analyses capable of providing some of the information outlined below is available in RG 4.24.

The following information relating to aquatic impacts should be included in the ER:

- Identification of the aquatic habitats that may be affected or lost by proposed building activities and description of the proposed construction methods used at these locations.
- Discussion of the construction BMPs that might be used to minimize impacts to aquatic resources.
- Basis for the proposed location of the intake and discharge structures in relationship to the presence and function of aquatic habitats and biota.
- Quantity and quality of habitat temporarily or permanently modified, lost, or fragmented as a result of building activities.
- Discussion of the tolerances and/or susceptibilities of important aquatic species on the site and in the vicinity to physical or hydrological alterations, runoff, turbidity, and chemical and noise (both surface and subsurface) pollution that may result from building activities.
- Spatiotemporal distribution shifts or behavioral alterations of important species that may result from building activities.
- A summary of any correspondence or discussions with FWS, National Marine Fisheries Service or, State, local, or Tribal natural resource agencies about the effect of building activities on important species or habitats including federally designated critical habitat. Briefly summarize and provide copies of key correspondence (e.g., letters, e-mails, or phone call summaries).

4.4 Socioeconomics

The ER should describe socioeconomic impacts that could occur in the region surrounding the proposed site as a result of building activities. Socioeconomic impacts from building activities occur primarily within the economic region identified in Chapter 2 of this RG. The economic region is defined by the demographic characteristics within the 50-mi region surrounding the proposed site. However, the analysis should consider the entire demographic region surrounding the site when appropriate. The scope of the review should be guided by the magnitude and nature of the expected impacts of building the

proposed project and by the site-specific community characteristics that may be affected by these activities.

4.4.1 Physical Impacts

This section should address the direct physical impacts to the community, including people, buildings, transportation infrastructure (roads, railways, and waterways), and the aesthetic quality of the local viewsheds directly attributable to building activities. The geographic scope for this discussion may be smaller than the economic region because, with the exception of aesthetics, physical impacts typically attenuate rapidly with distance. The applicant should provide the following information in the ER for:

- Potential impacts of noise from building activities on nearby residents, and nearby users of recreational facilities. The analysis should be based on the expected exposure of the closest residents to the proposed plant.
- Potential impacts of changes in air quality from building activities on nearby residents, and nearby users of recreational facilities. (e.g., odors, fugitive dust, and vehicle and machinery exhaust from building activities).
- Potential impacts to onsite and offsite structures from building activities (e.g., foundation damage from vibration caused by blasting or driving of piles).
- Description of the impacts resulting from any transportation infrastructure (e.g., roads, railways) realignments necessary to accommodate the project.
- The extent of expected road deterioration caused by heavy-haul activities, normal deliveries, and construction worker commuting. Any discussion of traffic-related impacts (e.g., additional congestion) should be deferred to the community infrastructure impacts section below.
- Anticipated increases in the repair and maintenance of transportation infrastructure necessary to compensate for expected deterioration.
- State or local ordinances, if any, that would require the applicant to contribute to transportation infrastructure improvements or repairs to support the project.
- Description of degradation in the aesthetic quality of the viewshed visible to the general public (discussion of aesthetic impacts to recreation should be deferred to the discussion of community infrastructure impacts), including:
 - Day and night visibility of the proposed site from changes to the existing landscape (e.g., timbering, clearing, and leveling),
 - Tall structures and equipment (e.g., cranes and towers), and
 - Night-time light nuisances (e.g., light pollution from work area illumination, aircraft warning lights, and light from night delivery vehicles).
- Description of all mitigating actions to be taken by the applicant and any Federal, State, local, Tribal, and industrial standards, regulations, ordinances, and practices related to reducing the direct physical impacts of building activities.

4.4.2 Demographic Impacts

The ER should contain a high-level discussion of expected population changes from building the proposed station with emphasis on demographic subcategories. The discussion of population changes should cover the entire demographic region with a focus on the economic region where the majority of impacts are expected to occur. The applicant should provide the following information in the ER:

- Text and summary tables presenting the expected direct workforce impacts on the local population from in-migrating construction workers. The information should account for the incremental increase in employment from operations staff present on the site while the plant is being built.
- Estimates, and accompanying assumptions and bases related to the general classifications of labor to be used for the proposed project, and the workforce scheduling, including the following:
 - starting date,
 - workforce schedule (e.g., hours per week, days per week, number of shifts, and percent of workforce by shift);
 - quantified monthly workforce increases and decreases over the entire construction period;
 - the magnitude and duration of the peak workforce;
 - post-peak workforce reductions; and
 - the number and timing for all operations workforce members present on the site during building.
- Discussion of expected residency patterns for in-migrating construction workers, including the following:
 - expected geographic origin of workers, including from within and outside the economic region, and within and outside the demographic region;
 - expected residential distribution of in-migrating workers within the economic region and the demographic region; and
 - discussion of in-migrating family characteristics, including family size, children disaggregated by age group (i.e., generally by non-school, elementary, middle, and high school ages, but may include other cohorts).
- Discussion of existing site employment (including outage workers) and the proposed project’s workforce (i.e., construction and operations workers) for proposed projects co-located with an operating power station.

4.4.3 Economic Impacts to the Community

Economic impacts from building activities include the stimulation of local economies toward new employment and new businesses. By definition, the area where these impacts are expected to occur is the economic region. Information from this section will inform the benefit-cost conclusions in Chapter 10 of the ER. The applicant should use an industry-standard economic input-output model to derive the impacts to the economic region from building activities. The discussion should include monetized estimates, to the extent practicable.

Economy

The applicant should include the following information in the ER on local economic impacts during building activities:

- Identification and description of the input-output model, input parameters used, and results generated. The output from most regional input-output models includes:
 - expected direct and indirect employment attributable to building activities; and

- expected direct and indirect income effects attributable to purchases and wages in support of building activities.
- Description of all assumptions affecting the conclusions drawn from this section, including the number of workers that drive the model, who will receive the benefits, and where in the economic region those benefits would most likely be found. If impacts are derived from a maximum impact as an input (e.g., peak employment), the discussion should describe how the model’s conclusions are affected by changes in that maximum impact.

Taxes

The applicant should provide a comprehensive list and discussion of the direct tax-revenue impacts attributable to building activities. Typical tax revenues include the following:

- Income – Federal, State, County, and local income taxes should be described. The applicant should include in this discussion all assumptions about the number of workers, their wages, and their work schedules that serve to fully inform the calculation of taxes.
- Sales and use – the applicant should ensure that, if present, State, County, and local sales and use taxes should be based on the contributions from new residents (i.e., in-migrating workers and their families), and from the applicant’s estimated local purchases of services, materials, and supplies. The discussion should include an explanation of the tax rate, the assumptions behind the calculation of revenues, and a monetized estimate for each tax entity.
- Property – local property taxes may or may not include revenues from the partially completed project and may be subject to special government incentives, payment-in-lieu-of-tax agreements, or other assessment processes that differ from those for the general public. The discussion should include an explanation of the tax rate, the assumptions behind the calculation of revenues, and a monetized estimate for each tax entity.

4.4.4 Community Infrastructure Impacts

Community infrastructure impacts include the expected changes to the communities and governments of the economic region attributable to building activities. Beginning with the baseline assessments found in Chapter 2 of this RG, the applicant should assess the change in each of the following categories and provide a detailed discussion of process and assumptions along with tables and/or figures that illustrate conclusions.

Traffic

The infrastructure impact to traffic differs from the physical impact to roads in that this assessment should discuss the consequences of the proposed project in terms of changes to the welfare and behavior of local residents. The discussion should be accompanied by sufficient tables and/or figures to support the analysis. The applicant should include the following information in the ER:

- traffic assessments discussing the magnitude and schedule of each shift relative to the baseline traffic for key affected roads;
- congestion and accident-related consequences of additional traffic from operations and outage workers for projects co-located with an operating nuclear station; and
- congestion and accident-related consequences of additional traffic from construction workers for the proposed project.

Recreation

Recreation impacts are the changes in recreational experience caused by changes to the viewshed, local environment, or quality and quantity of access to recreation venues. The applicant should base its recreation-impact determination on the local recreational venues, capacity, occupation rate, and seasonal characteristics provided in Chapter 2 of this RG. The analysis should include the following information:

- Aesthetic changes (e.g., lighted heavy machinery, worksite lighting and visual impacts of tall structures or equipment, as discussed under physical impacts) that reduce the attractiveness and enjoyment of recreational venues.
- Dust and other visible degradation that could reduce the attractiveness of recreational venues.
- Timber harvesting, other resource-extraction or other activities that could reduce the quantity of or eliminate recreational areas.
- Demographic changes caused by in-migrating construction workers that could increase competition for access to recreational venues and the impact such increased demand could produce.

Housing

The applicant should describe the expected impacts on local housing resources attributable to the site workforce during building activities. The discussion should be accompanied by sufficient tables and/or figures to support the analysis. The housing assessment should include the following:

- Expected number of in-migrating workforce members.
- The underlying assumptions, including:
 - family size,
 - in-migrating family residential geographical distribution, and
 - assumptions related to housing choice (e.g., rental housing; temporary or mobile housing, such as campgrounds and recreational vehicle parks; and permanent single-family housing options).
- The location of expected housing resources by type in the context of the total housing resource for each affected county in the economic region (from Chapter 2 of this RG).

Public Services

The applicant should describe the expected impacts to public services in the economic region attributable to the building-related in-migrating population. The discussion should be accompanied by sufficient tables and/or figures to support the analysis. The assessment of public services should include the impacts of increasing demand for public services by in-migrating workers and their families:

- Estimate of the expected contribution to water and sewer use for each affected community, and the resulting impact to each service in the economic region.
- Identification of the potential impact on police or fire services for each affected community in the economic region, including the expected increase in the number of employees (differentiated between duty officers and support staff), and the change in ratio of police or firefighters to the population in order to maintain the current level of service.

- Identification of the expected number of new volunteer staff (as opposed to employee staff) needed to maintain the same ratio of first responder staff to the population served.
- Estimate of the expected impacts to medical facilities in the demographic region.
- Estimate of the number of students that would be added because of in-migrating families, including the expected change in student-teacher ratios, with a comparison to any mandated maximum ratio.

4.5 Environmental Justice

This section should assess whether the pathways identified in the environmental justice (EJ) section of Chapter 2 of this RG result in any disproportionately high and adverse environmental and human health effects to minority or low-income populations of interest (“EJ populations of interest”) because of building the proposed project. Impacts to minority or low-income populations may arise from building activities at or near the site, in the local communities affected by the proposed project, including in offsite areas such as transmission-line corridors, and in the wider economic and demographic regions.

4.5.1 Environmental Impacts

The applicant should consider each area previously considered for socioeconomic, even if the area had a minor impact, and discuss those areas where a potential pathway could result in a disproportionately high and adverse effect on EJ populations of interest. The discussion should conclude with a determination of whether or not impacts of building would result in disproportionately high and adverse impacts on EJ populations of interest. The ER should also address potential mitigation actions or other mitigating factors that would reduce negative impacts.

4.5.2 Human-Health Effects

The applicant should include a qualitative (or quantitative, if more appropriate) discussion in the ER of the human-health pathways by which any environmental impact during building could result in disproportionate impacts on any EJ population of interest, including cultural and economic factors. The discussion should conclude with a determination of whether or not human health impacts of building may result in disproportionately high and adverse human-health effects on any EJ population of interest. The ER should also address potential mitigation actions or other mitigating factors that would reduce negative impacts.

4.5.3 Subsistence, Special Conditions, and Unique Characteristics

The applicant should describe the effects of building activities on any established resource dependencies, cultural practices, or subsistence behaviors at or in the vicinity of the site, or at offsite areas. The discussion should conclude with a determination of whether or not disproportionately high and adverse human health and environmental effects occur as a result of building the proposed project. The ER should address potential mitigation actions or other mitigating factors that would reduce negative impacts. Such information may include, but is not limited to:

- subsistence behavior (i.e., hunting, fishing, or other natural resource exploitation as an income supplement),
- unique cultural practices (e.g., American Indian religious and ceremonial reliance on natural resources such as sweet grasses, fish, and wild rice),

- special circumstances or unique characteristics, (e.g., minority communities identifiable in compact (smaller than a Census block group) locations, such as American Indian communities); and
- any disproportionately high socioeconomic characteristic (e.g., a high dependence on pedestrian transportation).

4.6 Historic and Cultural Resources

Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA) (54 U.S.C. 300101 et seq.), requires that Federal agencies consider the effects of the agency’s undertaking on historic properties included in, or eligible for, the National Register of Historic Places and, before approval of an undertaking, give the Advisory Council on Historic Preservation (ACHP), a reasonable opportunity to comment on the undertaking. The NHPA defines “undertakings” as any project or activity that is funded or under the direct jurisdiction of a Federal agency, or any project or activity that requires a “Federal permit, license, or approval.” The ACHP’s regulations at 36 CFR Part 800, “Protection of Historic Properties,” define the provisions for meeting Section 106 requirements.

If an applicant decides to commence building activities (e.g., site-preparation activities), the applicant should be cognizant of the anticipatory demolition statutory provision in Section 110(k) of the NHPA (54 U.S.C. 306113).¹⁰ For additional information, the applicant should refer to 36 CFR 800.9(c). The applicant is encouraged to engage the U.S. Nuclear Regulatory Commission (NRC) staff as early as possible in the planning process, in accordance with 10 CFR 51.40, “Consultation with NRC Staff,” to avoid issues such as anticipatory demolition.

The applicant should provide the information and analysis for the NRC to comply with Section 106 requirements in a manner that minimizes the potential for delays in the environmental review. The applicant should identify any activities and impacts associated with building that could affect historic and cultural resources within the APE (onsite or offsite, direct and indirect effects). Applicants should involve the State Historic Preservation Officer (SHPO), local historic preservation officials, and affected American Indian tribes in the assessment. The ER should include the following information (with appropriate reference to Chapter 2 of the ER to avoid duplication of information):

- Description of ground-disturbing activities (e.g., land clearing, grading, excavating, road work, and building the facility), increases in traffic, and audio and visual intrusions that could affect onsite and offsite resources.
- Description of historic properties found in the direct and indirect APEs that will be affected by the proposed project. Use the criteria specified in 36 CFR 800.5 to assess adverse effects on historic properties. Provide a basis and documentation for how a conclusion is reached.
- Description of historic and cultural resources that are not determined to be historic properties, but may be considered important in the context of National Environmental Policy Act of 1969, as amended (e.g., sacred sites, cemeteries, local gathering areas).
- Discuss the direct and indirect effects (e.g., ground disturbance, physical, visual, auditory, atmospheric such as fugitive dust, light, and traffic), if any, from the proposed project, and any

¹⁰ The NRC is required to comply with the NHPA including the anticipatory demolition clause, Section 110(k) of the NHPA (54 USC 306113).

associated transmission lines on nearby historic properties or important historic and cultural resources.

- For indirect effects, the assessment should include drawings or modified photographs indicating the station facilities and their surroundings, if visible from these nearby important vantage points.

The assessment should lead to one of three conclusions (see 36 CFR 800.4):

- No historic properties present.
- Historic properties present, but the undertaking will have no effect upon them.
- Adverse effect: The undertaking will harm one or more historic properties (see 36 CFR 800.5).

If a qualified professional has recommended a “no historic properties present” determination, then the applicant should provide supporting documentation in the ER.

If a qualified professional has recommended a finding of no adverse effect to historic properties based on the implementation of protective measures to minimize or avoid these effects, the applicant should formalize these protective measures in a protection plan in consultation with SHPO and other consulting parties and document this within the ER.

If a qualified professional determines that adverse effects to historic properties occur, the applicant should informally engage with the SHPO and affected American Indian tribes, local government, members of the public, and other affected parties and document this determination in the ER. The ER should describe any procedures and cultural resource management plans to protect historic and cultural resources during building activities as well as any measures to avoid, minimize or mitigate adverse effects. These procedures should also include steps to take in the event of inadvertent discoveries, including the discovery of human remains.

The applicant should be aware that the NRC staff will also be consulting with the SHPO, affected American Indian tribes and interested parties through the Section 106 process. If the NRC determines an adverse effect will occur, it will in accordance with 36 CFR Part 800 develop proposed measures in consultation with the identified consulting parties that might avoid, minimize, or mitigate such effects. Such measures, as appropriate, would be discussed in the NRC staff’s environmental impact statement. If the NRC staff determines that adverse effects exist, it can develop a Memorandum of Agreement or Programmatic Agreement (See 36 CFR Part 800), as appropriate. See Appendix B for additional information on consultation.

4.7 Air Resources

The applicant should describe meteorological and air-quality impacts associated with building activities. The description should include the following:

- Identification of applicable local, State, and Federal air regulations and required air permits for construction.
- Sources and types of air pollutant emissions, including mitigating measures and plans to minimize air emissions.
- Estimates of building schedule and associated annual air emissions for criteria air pollutants identified in the National Ambient Air Quality Standards. If the proposed site is located in a nonattainment or maintenance area with respect to a criteria pollutant, the emission estimates can

be used as a basis for assessing the applicability of a conformity analysis (see 40 CFR 93, “Determining Conformity of Federal Actions to State or Federal Implementation Plans,” Subpart B (Ref. 55), and NRC Memorandum, “Revision to Staff Guidance for Conducting General Conformity Determinations” (Ref. 56)).

- Estimates of greenhouse gas (GHG) emissions (expressed in units of CO₂ equivalents), including GHG emissions from on-road construction vehicles, commuter vehicles, non-road construction equipment, marine engines, and/or locomotive engines and comparison of these GHG emissions to state and national GHG emissions from Chapter 2. The applicant may provide either a site-specific analysis or refer to the generic GHG footprint for a 1000-MW(e) reactor outlined in COL-ISG-26¹¹ or subsequent interim staff guidance documents or other regulatory guidance. The assumptions, factors, and other information used in any site-specific analysis should be described in sufficient detail to allow an independent evaluation and assessment of the resulting GHG emissions estimate.

4.8 Nonradiological Health

The applicant should describe the non-radiological health impacts associated with building activities, including impacts to public and occupational health, noise, and traffic.

4.8.1 Public and Occupational Health

The applicant should describe the impacts from building activities on public and worker nonradiological health. The description should include the following:

- public health risks from building activities (e.g., air pollution from dust and vehicle emissions)
- occupational health risks to workers and onsite personnel from activities such as building, maintenance, testing, excavation and modifications
- estimate of the total occupational injuries and illnesses for building activities anticipated for the project, including information on interpretation of the statistical results
- description of safety standards, practices, and mitigation procedures that will be used to reduce public and occupational health risks

4.8.2 Noise

The applicant should describe noise impacts associated with building activities, including the following:

- applicable Federal, State, and local regulations and/or ordinances governing noise from building activities
- sources of noise at the site, such as heavy equipment operation
- peak noise level measurements and attenuation with distance for the sources of noise at the site
- description of the levels of noise at the closest noise-sensitive receptors, including a description of any noise-abatement models

¹¹ Guidance in COL-ISG-026 will be superseded by the next revision of NUREG-1555.

- any BMPs required or planned for noise abatement

4.8.3 Transportation of Construction Materials and Personnel to and from the Proposed Site

The applicant should provide estimates of the potential health impacts from nonradiological traffic-related accidents related to transporting construction materials and workers to and from the proposed site. Nonradiological impacts refer to the accidents, injuries, and fatalities estimated to occur from traffic accidents during movement of construction materials and personnel to and from the proposed site during building. Where possible, the impacts should be estimated using information specific to the proposed site (e.g., by using county-specific accident statistics). The following information should be provided:

- Summary of provisions for site access during building, including during outages of co-located operating units.
- Description of the method(s) used to estimate nonradiological traffic-related accident impacts, including traffic accidents, injuries, and fatalities. Traffic-related accident impacts should be estimated using round-trip distances. The impacts should account for both construction workers and shipments of construction materials.
- Specification of input parameters and sources used in the impact assessment. Parameters and source documents should be defensible and should be consistent with parameters used for socioeconomic analysis to determine physical impacts to road and traffic assessments for key roads. If assumptions are used to fill in missing or highly uncertain data (e.g., commute distances, persons per vehicle, and shipping distances for materials), the assumptions should be bounding and reasonable (i.e., the assumptions used in the analysis would be broad enough to overestimate the transportation impacts yet not so broad that they could mask the true environmental impacts of the reactor and lead to invalid conclusions).
- Annual number of traffic accidents, injuries, and fatalities.
- Computer code input and output files used to estimate transportation impacts.

4.9 Radiological Health

The applicant should evaluate the potential radiological impacts on the proposed project's construction workforce that includes the radiological sources located on the project site or adjacent to the site, such as an operating or shutdown nuclear plant or other nuclear fuel-cycle facility.

For multi-unit or multi-modular reactors, the applicant should provide estimated annual doses to construction workers in a new unit or module construction area, as a result of radiation from onsite radiation sources from the existing operating plant(s). Examples of typical onsite radiation sources include the turbine systems (for boiling water reactors), stored radioactive wastes, the independent spent fuel storage installation, auxiliary and reactor buildings, and radioactive effluents (i.e., direct radiation from the gaseous radioactive effluent plume). The ER should be consistent with the applicable sections of the final safety analysis report (FSAR), especially for the location of the maximum exposure. Sections 12.3 and 12.4 of the Standard Review Plan (SRP), NUREG-0800 (Ref. 57), require an assessment of dose to construction workers on a facility adjacent to an existing nuclear unit or units. The applicant should provide the annual person-rem (or person-Sievert) doses associated with such construction areas, providing detailed information as to the estimated number of construction workers and estimated annual doses (from direct, gaseous, and liquid sources) to these workers, including bases, models, assumptions, and input data. The applicant should also describe any additional dose-reducing measures taken as a result of the dose assessment process for specific functions or activities and indicate

whether and, if so, how the applicant has followed the guidance in the most recent version of RG 8.19 (Ref. 58), “Occupational Radiation Dose Assessment in Light-Water Reactor Power Plants -- Design Stage Man-Rem Estimates.” Conversely, if the applicant has not followed this guidance, then the specific acceptable alternative methods used should be described in sufficient detail.

The ER should use the same units of measure as used in the FSAR. The ER should include the following:

- the physical layout of the site, including the location and orientation of onsite, adjacent existing operating nuclear units or co-located reactor modules or permanently shutdown units
- whether the construction worker would be considered a member of the public or a radiation worker and the basis for that assumption

4.9.1 Direct Radiation Exposures

In the ER, the applicant should provide the following:

- The sources of direct radiation exposures: These sources should include, but not be limited to, independent spent fuel storage facilities, radioactive waste handling facilities, low-level waste storage facilities, condensate storage tanks, skyshine, and operating or permanently shutdown nuclear facilities co-located at the site.
- The estimated dose rate from direct radiation to construction workers from each source and provide the assumptions and methods used for estimating the dose.
- The number and principal locations of construction workers who will be exposed to the radiation sources described below and the total amount of time per year that they will spend at those locations.

4.9.2 Radiation Exposures from Gaseous Effluents

In the ER, the applicant should provide the following:

- Radioactive gaseous release data from the operating units, co-located units, or permanently shutdown units. The applicant should provide the location of the major gaseous effluent release points. The applicant should address the assumptions for using this release data (the year or years of data used and why this data is used or other release data such as from the design control document (DCD) for the reactor design).
- An estimate of the annual total effective dose equivalent from the gaseous effluents to a construction worker, providing the assumptions and methods used to make the estimate.

4.9.3 Radiation Exposures from Liquid Effluents

In the ER, the applicant should provide the following:

- Radioactive liquid effluent release data from the operating units, co-located units, or permanently shutdown units. The applicant should provide the location of the major liquid effluent release points. The applicant should address the assumptions for using this release data (the year or years of data used and why this data is used or other release data such as from the DCD for the reactor design).
- An estimate of the annual total effective dose equivalent from the liquid effluents to a construction worker, providing the assumptions and methods used to make the estimate.

4.9.4 Total Dose to Construction Workers

In the ER, the applicant should provide the following:

- Estimated annual dose to an individual construction worker, including the location of maximum exposure, all models, assumptions, and input data used in arriving at the dose.
- Estimated annual collective dose to the construction work force, including all models, assumptions, and input data used in arriving at the dose.
- If construction workers are classified as members of the public, a comparison of the estimated annual dose to an individual construction worker to the dose criteria for a member of the public (10 CFR 20.1301, “Dose Limits for Individual Members of the Public;” 20.1302, “Compliance with Dose Limits for Individual Members of the Public”). If construction workers are classified as radiation workers (which would require certain training), compare the individual construction worker dose to 10 CFR 20.1001, “Purpose”; 20.1201, “Occupational Dose Limits for Adults”; 20.1203, “Determination of External Dose from Airborne Radioactive Material”; and 20.1204, “Determination of Internal Exposure.”

4.10 Nonradioactive Waste

The applicant should describe the environmental impacts that could result from the generation, handling, and disposal of nonradioactive waste during building activities. As discussed in Chapter 3 of this RG, the types of nonradioactive waste that would be generated, handled, and disposed of during building activities include cleared vegetation, building material debris, municipal waste, spoils, stormwater runoff, sanitary waste, dust and other air emissions, used oils and lubricants from vehicle maintenance, and other hazardous chemicals.

4.10.1 Impacts to Land

The applicant should describe the impacts to the land resulting from generation, handling and disposal of nonradioactive waste during building of the project. The description should include the following:

- summary of pertinent portions of the discussion from the section related to land-use impacts from building activities;
- plans for storing and disposing of cleared vegetation or soil, rock or other resulting debris;
- general description of onsite waste expected to be generated, including types and approximate quantities, from building and equipment maintenance activities and the workforce; and
- plans for disposal of waste, including plans to minimize or recycle generated waste.

4.10.2 Impacts to Water

The applicant should describe the impacts from liquid waste generated during building activities. The description should include the following:

- Types of liquid waste generated during building and equipment maintenance activities.
Typically, liquid wastes are from sanitary wastewater-treatment systems and stormwater runoff or from vehicle maintenance activities.
- Plans for onsite or offsite treatment of liquid waste.

- Any State or local codes or regulations that require provisions for treatment.
- Permits required for treatment and disposal of liquid waste.

4.10.3 Impacts to Air

The applicant should describe the building activities that would generate impacts to air quality. The applicant should identify if these impacts have been addressed in the Air Resources section of this Chapter. The description should include the following:

- Activities that would generate dust or emissions that might impact the air quality (e.g., burning vegetation and combustion of fuel in equipment). Include any temporary activities that might be necessary for building activities (e.g., an onsite concrete batch plant). Activities could be onsite or along transmission corridors.
- Any State or local codes that govern air quality (e.g., bans on burning materials).

4.11 Measures and Controls to Limit Adverse Impacts During Construction Activities

Environmental measures and controls may be required during building activities to minimize effects to the environment. In addition to the discussion of the effects of building, the applicant should furnish details of the programs with which it plans to monitor those activities affecting site-related environmental resources and quality, and describe the duration of these efforts. A description of the measures and monitoring required for compliance with Federal, State, and local environmental regulations and laws should also be provided for each resource area. The description should include plans for restoration, protection of resources or development of appropriate substitutes, and measures taken to control adverse impacts to resources. The applicant should describe measures designed to mitigate or reverse undesirable effects such as those described previously for each resource area. Table 4-1 is an example of the types of measures and controls to be documented.

Table 4-1. Summary of Measures and Controls to Limit Adverse Impacts During Construction Activities

| Impact Category | Planned Measures and Controls During Construction |
|------------------------------|--|
| Land-Use Impacts | |
| Site and Vicinity | Measures and controls that minimize impacts |
| Transmission Corridors | Measures and controls that minimize impacts |
| Offsite Areas | Measures and controls that minimize impacts |
| Water-Related Impacts | |
| Hydrologic Alterations | Measures and controls that describe alterations to surface waters and flow and groundwater |
| Water Use | Measures and controls that describe availability of use of surface and groundwater resources |
| Water Quality | Measures and controls that minimize impacts on surface and groundwater |

| | |
|---|--|
| | |
| Ecological Impacts | |
| Terrestrial Ecosystems | Measures and controls to minimize adverse impacts on terrestrial resources (including wetlands) onsite, offsite, and special permitting that may be required for managed species |
| Aquatic Ecosystems | Measures and controls to minimize adverse impacts on aquatic resources onsite, offsite, and special permitting that may be required for managed species |
| Socioeconomic Impacts | |
| Social and Economic | Physical, Economic (Economy and Taxes), and Socioeconomic (Traffic-, Recreation-, Housing-, Public Services- and Education-related) measures and controls to mitigate impacts. |
| Environmental Justice | Measures and controls that minimize impacts |
| Historic and Cultural Resources | Measures for identification, consultation, and preservation following discovery |
| Air Resources | Controls to minimize dust, emissions |
| Nonradiological Health | Measures and controls for worker safety |
| Radiation Exposure to Construction Workers | Controls and monitoring for minimization of dose to construction workers |
| Nonradioactive Waste | Disposal plan for solid, liquid, gaseous wastes, sanitary waste |

Chapter 5

5.0 Environmental Impacts from Operation of the Proposed Plant

The environmental report (ER) should adequately describe the impacts of operating the proposed plant as required in Title 10 of the *Code of Federal Regulations* (10 CFR) 51.45(c). For each impact category in Chapter 5, the ER should identify the measures and controls that would be used to mitigate and limit adverse operational environmental impacts. Specific information to include in the ER, as part of, or in addition to, the description of impacts, is covered in the following sections.

5.1 Land Use

The greatest land-use impacts are typically associated with building activities. Land-use impacts associated with operations are expected to be minimal, because activities are generally restricted to previously disturbed areas of the site or offsite areas (e.g., outage worker parking, temporary access routes, periodic vegetation clearing, landscaping, and sporadic access closures). The scope of the review is guided by the magnitude and nature of the expected impacts associated with proposed plant operations and site-specific characteristics. Impacts should be quantified to the extent possible using acreage, volumetric, or chronological measures.

5.1.1 Onsite Impacts

The following information relating to the land-use impacts associated with operations should be included in the ER:

- characterization of any land-disturbance activities expected during operations (e.g., maintenance and operations activities and construction of additional waste storage facilities, including an independent spent fuel storage installation)
- discussion of any anticipated land-use classification conversions summarized by acreage
- discussion of any changes in land uses on agricultural, forestry, or mineral extraction activities or on floodplains or wetlands (can cross-reference other sections of ER where possible)
- description of impacts to the provisions of any affected local or regional land-use or economic-development plans associated with operations
- description of any disruption to land- or water-resource access issues or concerns during operations
- description of any disruption to existing land uses or private land access issues or concerns at the site or vicinity caused by operations

5.1.2 Offsite Impacts

The following information relating to the land-use impacts associated with operations in offsite areas should be included in the ER:

- discussion of expected transmission-line corridor maintenance activities during operations affecting land use
- characterization of any land-disturbance activities in other offsite areas expected during operations
- discussion of land-use classification conversions summarized by acreage

- description of impacts to local or regional land-use or economic-development plans from operations in offsite areas
- description of any disruption to land- or water-resource access required to facilitate operations
- description of any disruption to existing land uses or private land access at the site or vicinity caused by operations
- discussion of any changes in land uses on agricultural, forestry, or mineral extraction activities or on floodplains or wetlands (can cross-reference other sections of ER where possible)

5.2 Water Resources (Surface Water and Groundwater)

The applicant should describe the hydrologic alterations associated with station operation and the resulting impacts on consumptive and nonconsumptive water uses and on water quality. In evaluating water-related impacts, the applicant should consider the effects of reasonably foreseeable changes in the hydrologic environment (e.g., climate, land use, and water use) over the duration of the license for the region of interest (ROI).

5.2.1 Hydrologic Alterations

The applicant should describe the operational activities expected to result in hydrologic alterations at the site, within transmission corridors, and offsite within the ROI. Examples of operational activities that might affect water use and water quality include, withdrawal of water for station use, surface-water diversions, maintenance dredging, groundwater dewatering, and effluent discharge, etc. The description should include analyses of the resulting hydrologic alterations and the physical effects of these alterations on water uses and users (quantity and quality); practices proposed to minimize hydrologic alterations having adverse effects; and an assessment of compliance with the applicable Federal, State, regional, local, and affected American Indian Tribal standards and regulations.

Station water use and discharge of effluents during operation are requested in Chapter 3 of this RG. The applicant should identify those water-supply and water-quality conditions under which station operation would be affected (e.g., derating caused by insufficient supply of cooling water).

The ER should include a description of the following:

- Anticipated hydrologic alterations resulting from station operation. For example, the applicant should discuss alterations in water levels and groundwater heads; alterations in flow rates and circulation patterns caused by diversion, intake, and discharge structures; and alterations in erosion, deposition, and sediment transport characteristics.
- The effects of these alterations on the quantity and availability of water within the ROI. For example, the applicant should assess, as applicable, how hydrologic alterations affect river discharge (including changes in the seasonal variation of flow) or groundwater discharge to wetlands.
- The effects of effluent discharge on the water quality of the receiving waterbodies. Thermal, chemical, and radiological effects should be evaluated.
- The proposed actions to minimize the effects of the hydrologic alterations.
- Applicable standards and regulations.

When a mathematical model is used to evaluate the effects of hydrologic alterations, the applicant should describe the conceptual basis for the model (including the rationale for eliminating plausible

alternative conceptualizations), the assumptions used in developing the model, the range of applicability of the model, input data used, the basis for boundary conditions, parameter estimation and calibration procedures followed, and estimates of uncertainty in model forecasts. The applicant should provide sufficient data to permit staff evaluation of modeling results, including input files used to obtain the model results and a description of any post-modeling analyses used by the applicant.

5.2.2 Water-Use Impacts

The applicant should identify those water uses and water users discussed in Chapter 2 of this RG that are potentially affected by the changes in the quantity and/or availability of water resulting from hydrologic alterations. The applicant should evaluate the water-use impacts by quantifying the anticipated reduction in water-supply reliability for each water use and provide a description of the analyses performed to determine the impacts during operations.

5.2.3 Water-Quality Impacts

The applicant should identify those water uses and water users discussed in Chapter 2 of this RG that are potentially affected by the changes in water quality resulting from hydrologic alterations during operations. The applicant should evaluate the impacts by quantifying the anticipated reduction in each use resulting from the changes in water quality and provide a description of the analyses performed to determine the impacts.

5.2.4 Water Monitoring

The overall plan for protection of waterbodies that may be affected by station operations should be discussed. A description of the proposed measures to ensure compliance with applicable water-quality and water-use standards and regulations should also be provided. When compliance involves monitoring, the operational monitoring program should be described in sufficient detail to justify the ability of the monitoring to provide timely and accurate information so that appropriate actions can be taken to limit the impacts of station operations.

5.3 Ecological Resources

This section addresses the information related to terrestrial, wetland and aquatic ecological impacts from operations at the proposed site. The applicant should provide adequate details in the ER to fully determine the impacts to terrestrial and aquatic species and habitats resulting from nuclear power plant operations.

5.3.1 Terrestrial and Wetland Impacts

Operation of a nuclear power plant, once built, does not normally involve further physical loss of terrestrial habitats or wetlands but can still affect habitat quality and wildlife. Supplementary guidance on some of the more common terrestrial ecology environmental impact analyses is available in the most recent revision of RG 4.11.

Terrestrial Habitats

The ER should include a discussion of the following potential effects on terrestrial habitats from operating the proposed nuclear power plant:

- Effects on terrestrial habitats from land-disturbance activities expected (e.g., construction of additional waste storage facilities, including an independent spent fuel storage installation if the applicant has current plans to build such a facility).
- Effects on terrestrial habitats from facility- and landscape-maintenance activities (e.g., pesticide use, mowing, danger tree trimming and removal, and trampling by heavy equipment).
- Effects of runoff and stormwater management on wetlands and other terrestrial habitats. Ensure compatibility with hydrology sections.
- Salinity from cooling-tower drift, or drift from operating other facilities (e.g., evaporation ponds), to affect terrestrial resources. If the maximum estimated ground-level salinity deposition exceeds 1 kg/ha/mo at any location at any time, also include deposition isopleths overlaid on terrestrial habitat maps and an estimate of the area of each habitat type included in each isopleth band.
- Fogging and icing that could affect terrestrial species and habitats.
- Operation of cooling ponds, evaporation ponds, and other operational water features that could affect adjoining wetlands and other terrestrial habitats.
- Use of groundwater and surface water to affect terrestrial habitats (e.g., wetlands, shorelines, and riparian habitats). An overlay of modeled groundwater withdrawal isopleths over terrestrial habitat maps may be helpful if withdrawals could be capable of causing substantial habitat modifications. Information should be consistent with similar information presented in the aquatic ecology and hydrology sections of the ER.

Wetlands

Operating a nuclear power plant does not normally involve filling wetlands. However, wetlands are a habitat type that should be addressed together with upland (non-wetland) terrestrial habitat types. Particular attention should be paid to the possibility that groundwater withdrawals could affect the hydrology of nearby wetlands and that surface-water withdrawals could affect nearby shorelines and wetlands fringing water sources.

Wildlife

The ER should include a discussion of the following potential effects on terrestrial wildlife during operations:

- Effects of operational noise (e.g., mechanical noise, vehicular noise, and noise from cooling towers) on terrestrial wildlife. Estimated noise isopleth overlays may be helpful if noise levels exceeding 85 dBA are anticipated in areas of high-quality habitat.
- Loss or injury of wildlife caused by traffic. Wildlife movement and migration patterns over the surrounding landscape should be considered. The discussion should remain consistent with traffic-related discussions presented elsewhere in the ER.
- Effects on terrestrial wildlife from maintaining transmission-line rights-of-way and other exterior areas and corridors.
- Injury to birds and bats colliding with tall structures (e.g., natural draft cooling towers, communication towers, and electric transmission lines).
- Electrocution of birds and other wildlife by transmission lines and other electrical facilities.

- Effects on terrestrial wildlife from electromagnetic radiation generated at switchyards and along electric transmission lines.

Important Species and Habitats

Applicants should carefully consider which species and habitats that meet the criteria for importance in Table 2-1 could potentially be affected over the operational life of the proposed plant. The ER should include the following information with respect to potential effects of operations on important species and habitats:

- A discussion of how operation could affect terrestrial species and habitats identified as important using the criteria in Table 2-1.
- A discussion of any relevant correspondence that has been initiated with the U.S. Fish and Wildlife Service (FWS) or State, local, or Tribal natural resource agencies about endangered, threatened or other special status species and habitats. The applicant should briefly summarize and provide copies of key correspondence (including requests and responses by letters, e-mail, or phone call summaries).
- Cross-references to the aquatic ecology section below may be appropriate for important species using both terrestrial and aquatic habitats (e.g., some waterfowl).

5.3.2 Aquatic Impacts

Operation of a nuclear power plant would affect the aquatic environment. Supplementary guidance on aquatic ecology environmental impact analyses is available in RG 4.24.

The ER should include the following information relating to operational aquatic impacts:

- Description of the water withdrawal and consumptive water use from station operations and its effects on aquatic resources.
- Discussion of the conformance of the proposed intake structure to the U.S. Environmental Protection Agency (EPA) 316(b) national technology-based performance and proportional-flow requirements (66 FR 65256) (Ref. 59) for Phase I for new facilities.
- Information on National Pollutant Discharge Elimination System (NPDES) permits for the proposed site and/or current NPDES permit for existing units sited in proximity to the proposed units.
- Description of the susceptibility of important aquatic species at specific life stages to entrainment, and impingement in conjunction with operation of the plant cooling-system and entrainment or impingement rates from operation of the plant using data from studies as discussed in RG 4.24, including existing historical data from studies from co-located or nearby nuclear or fossil units.
- Discussion of stock assessments, if available and appropriate, as a metric for impact to the species for those important species potentially affected by station operation.
- Discussion of species and habitats that may be adversely affected by periodic operations, (e.g., thermal backwashing).
- Discussion of species that may be affected by potential adverse effects from recirculation of heated effluent from the plant-discharge system, and altered hydrodynamic characteristics including altered circulation or current patterns. Discussion of habitats affected by the cooling-water system including bottom scouring near the discharge.

- Discussion of the temperature tolerance, duration of exposure, and avoidance behavior of susceptible important aquatic species in relation to thermal discharge, including heat shock and cold shock, at all affected life stages. This discussion should be based on a model, map and description of the thermal plume and should include variation seasonally and throughout the water column.
- Description of any potential changes to vectors causing aquatic species disease as a result of thermal discharges.
- Description of any potential changes to numbers of nuisance, invasive, and introduced species, including fish, aquatic vegetation and benthic invertebrates (e.g., *Corbicula* spp. or *Mytilus* spp.) onsite or in the vicinity of the proposed plant as a result of thermal discharges.
- Discussion of effects on important aquatic species resulting from chemical alterations (e.g., changes in salinity, dissolved oxygen, and biocides) to the receiving waterbody. Consider effects from both cooling-tower drift and cooling-system discharges.
- Discussion of effects on important aquatic species resulting from physical alterations (e.g., maintenance dredging to the receiving waterbody) including its substrate and aquatic vegetation.
- Description of any transmission-line and pipeline corridor maintenance practices anticipated to adversely affect aquatic biota.
- Summary of any relevant correspondence or discussions with FWS, National Marine Fisheries Service or State, local, or Tribal natural resource agencies on the endangered, threatened or other special status species and habitats including federally designated critical habitat. Briefly summarize and provide copies of key correspondence (including requests and responses by letters, e-mail, or phone call summaries).

5.4 Socioeconomics

The ER should describe the socioeconomic impacts from operations on the economic region identified in Chapter 2 of this RG. The economic region is defined by the characteristics within the demographic region surrounding the proposed site. However, the analysis should consider the entire 50-mi radius of the demographic region surrounding the site when appropriate. The scope of the review is guided by the magnitude and nature of the expected impacts associated with operations and by the site-specific community characteristics.

5.4.1 Physical Impacts

This section should address the physical impacts to the community, including people, buildings, roads, and the aesthetic quality of the local viewsheds directly attributable to operations. Physical impacts include the effects of noise, odors, exhausts, thermal emissions, and visual intrusion. The geographic scope for this discussion may be smaller than the economic region, because physical impacts typically attenuate rapidly with distance. The applicant should provide the following information in the ER:

- Potential noise impacts directly attributable to operational activities to nearby residents and nearby users of recreational facilities. The applicant should base its analysis on the impacts to the closest residents to the proposed plant.
- Potential impacts of odors from operational activities on nearby residents and nearby users of recreational facilities. The analysis should be based on the expected exposure of the closest residents and facilities to the proposed plant.

- Potential impacts of changes in air quality from operational activities (e.g., auxiliary generator exhaust) on nearby residents and nearby users of recreational facilities.
- Potential impacts to structures from operational activities (e.g. damage to structures from cooling tower drift (salt deposition)).
- The extent of expected deterioration in the transportation infrastructure (roads, rails, waterways) caused by heavy-haul activities, normal deliveries, and worker commuting, including any anticipated increases in necessary road repair and maintenance. Discussion of traffic-related impacts (e.g., additional congestion) should be deferred to the discussion of community infrastructure impacts.
- Description of degradation in the aesthetic quality of the viewshed visible to the general public (discussion of aesthetics impacts to recreation should be addressed as community infrastructure impacts), including:
 - day and night visibility of new structures or the cooling tower plumes at the proposed site in conflict with the existing viewshed (e.g., tall structures blocking views), and
 - nighttime light nuisances (e.g., light pollution from the security lighting, warning lights for aircraft and lights from night delivery vehicles)
- Description of all mitigating actions to be taken by the applicant and any Federal, State, local, Tribal, and industrial standards, regulations, ordinances, and practices for mitigating the direct physical impacts of operational activities.

5.4.2 Demographic Impacts

The ER should contain a high-level discussion of expected population changes from operation with emphasis on demographic subcategories. The discussion of population changes should cover the entire demographic region with a focus on the economic region where the majority of impacts are expected to occur. The applicant should provide the following information in the ER:

- Total expected in-migrating operations workforce by county and, if appropriate, community, including:
 - family size and age of children disaggregated into age group as discussed in Chapter 4,
 - discussion and rationale for the expected residency
 - summary tabular presentation of expected operations and outage workforce impacts by geographic area (i.e., by county and, if useful, major urban area)
- Discussion of the expected geographic location of operations workers already within the economic and demographic regions.

5.4.3 Economic Impacts to the Community

Economic impacts from operation activities include the stimulation of local economies toward new employment and new businesses. By definition, the area where these impacts are expected to occur is the economic region. Information from this section will inform the benefit-cost conclusions in Chapter 10 of the ER. The applicant should use an industry-standard economic input-output model to derive the impacts to the economic region from operation activities. The discussion should include monetized estimates, to the extent practicable.

Economy

The applicant should include in the ER the following information relating to local economic impacts during operations over the licensed life of the proposed plant:

- Identification and description of the input-output model, input parameters used, and results generated. The output from most regional input-output models includes:
 - expected direct and indirect employment attributable to operations
 - expected direct and indirect income effects attributable to purchases and wages in support of operations
- Description of all assumptions affecting the conclusions drawn from this section, including the number of workers that drive the model, who will receive the benefits, and where in the economic region those benefits would most likely be found. The discussion should describe how the model's conclusions are affected by changes in the assumed number of workers.

Taxes

To the extent possible the applicant should quantify direct tax-revenue impacts attributable to operation of the proposed project, based on the tax rate data from Chapter 2. Typical tax revenue discussions include the following:

- Income - Federal, state, and county income taxes during operations. The applicant should include in this discussion all assumptions about the number of workers, their wages, and their work schedule to fully inform the calculation of taxes.
- Sales and use - If present, State, County, and local sales and use taxes should be reported based on the contributions from new residents (i.e., in-migrating workers and their families) and from the applicant's estimated local purchases of services, materials, and supplies. The discussion should include an explanation of the tax rate, the assumptions behind the calculation of revenues, and a monetized estimate for each tax entity.
- Property - Local property taxes during operations will most likely be the largest beneficial impact from the proposed project and may be subject to special government incentives, fee-in-lieu-of-tax agreements, or other assessment processes that differ from those for the general public. The discussion should refer to the baseline in Chapter 2 and include quantifying (in monetary terms) property tax payments over the 40-year life of the project.

5.4.4 Community Infrastructure Impacts

Community impacts include all changes to the communities and governments of the economic region attributable to operations. Beginning with the baseline assessments found in Chapter 2, the applicant should assess the change in each of the following categories and provide a detailed discussion of process and assumptions, tables and/or figures that illustrate conclusions:

Traffic

The infrastructure impact to traffic differs from the physical impact to roads in that this assessment should discuss operations-related changes to the welfare and behavior of local residents—primarily through traffic congestion during commuting times. The discussion should be accompanied by sufficient tables and/or figures to support the analysis. The applicant should include traffic assessments discussing the magnitude and schedule of each shift relative to the baseline traffic for the key affected

roads for all operations workers, as well as congestion and accident-related consequences from outage workers.

Recreation

Recreation impacts are the changes in recreational experience caused by operations-related changes to the viewshed, local environment, or quality/quantity of access to recreation venues. The applicant should base its recreation impact determinations on the local recreational venues, capacity, occupancy rate, and seasonal characteristics provided in Chapter 2 of this RG. The analysis should include, but not be limited to, the following information:

- Aesthetic changes (e.g., impaired views and visible emissions) as discussed under physical impacts that reduce the attractiveness of and enjoyment of recreational venues.
- Dust, plumes or any other degradations to visibility that could reduce the attractiveness of recreational venues.
- Potential noise impacts directly attributable to operational activities to nearby recreational venues.
- Demographic changes resulting from the in-migrating operations workforce that could cause additional competition for access to recreational venues and the impact that such increased demand could produce.

Housing

The applicant should describe the expected impacts on local housing resources attributable to the operations workforce over the 40-year life of the proposed project. Sufficient tables and/or figures to support the analysis should accompany all discussion. The housing assessment should include the following:

- The expected number of in-migrating workforce members.
- The underlying assumptions, including:
 - family size
 - operations worker residential distribution
 - assumptions related to housing choice (e.g., rental housing, purchase of existing homes versus new construction).
- The location of expected housing resources by type in the context of the total housing resource for each affected county in the economic region (from Chapter 2).
- Whether the housing pressure for new residents creates adverse impacts on the rental market.

Public Services

The applicant should describe the expected impacts to public services in the economic region attributable to the operations-related in-migrating population. The discussion should be accompanied by sufficient tables and/or figures to support the analysis. The assessment of public services should include the impacts of increasing demand for public services by workers and their families:

- Estimate of the expected contribution to water and sewer use for each affected community, and the resulting impact to each service in the economic region.

- Identification of the potential impact on police or fire services for each affected community in the economic region, including the expected increase in the number of employees (differentiated between duty officers and support staff), and the change in ratio of police or firefighters to population in order to maintain the current level of service.
- Identification of the expected number of new volunteer staff (as opposed to employee staff) needed to maintain the same ratio of first responder staff to population served.
- Estimate of the expected impacts to medical facilities in the demographic region.
- Estimate of the number of students that would be added because of in-migrating families, including the expected change in student-teacher ratios, with a comparison to any mandated maximum ratio.

5.5 Environmental Justice

This section should assess whether the pathways identified in the environmental justice (EJ) section for the affected environment (Chapter 2 of this RG) result in any disproportionately high and adverse environmental and human health effects to minority or low-income populations (“EJ populations of interest”) during operation. Impacts to the minority and low-income populations could arise from operational activities at or near the site, in the local communities affected by the proposed project (including in offsite areas such as transmission-line corridors), and in the wider economic and demographic regions.

The applicant should consider the potential for disproportionately high and adverse impacts for each economic region even if that area was determined to have an impact that was minor. The applicant should assess each of the pathways identified in the environmental justice section for the affected environment against each economic region with regard to the potential for operation-related impacts. The applicant will need to consult across the resource areas covered in the ER to determine whether impacts from operations could create a pathway leading to disproportionately high and adverse impact on any minority or low-income populations of interest.

5.5.1 Environmental Impacts

The applicant should consider each area previously identified in the socioeconomics section for operation, even if the area had a minor impact, and discuss those areas where a potential pathway could result in a disproportionately high and adverse effect on minority or low-income populations of interest. The discussion should conclude with a determination of whether or not impacts of operations would result in disproportionately high and adverse impacts on minority or low-income populations of interest. The ER should also address potential mitigation actions or other mitigating factors that could reduce negative impacts.

5.5.2 Human-Health Effects

The applicant should include a qualitative (or quantitative, if more appropriate) discussion in the ER of the human-health pathways by which any environmental impact during operation could result in disproportionate impacts on any minority or low-income population (including radiological, cultural and economic factors). The discussion should conclude with a determination of whether or not human health impacts of operation could result in disproportionately high and adverse human-health effects during operations. The ER should address potential mitigation actions or other mitigating factors that would reduce negative impacts.

5.5.3 Subsistence, Special Conditions, and Unique Characteristics

The applicant should describe the effects of operational activities on any established resource dependencies, cultural practices, or subsistence behaviors at or in the vicinity of the site, or at offsite areas. The discussion should conclude with a determination of whether or not disproportionately high and adverse human health or environmental effects could occur as a result of operations. The ER should address potential mitigation actions or other mitigating factors that would reduce negative impacts. Such information may include, but is not limited to:

- subsistence behavior (i.e., hunting, fishing, or other natural resource exploitation as an income supplement)
- unique cultural practices (e.g., American Indian Tribal religious and ceremonial reliance on natural resources such as sweet grasses, fish, and wild rice)
- special circumstances or unique characteristics, (e.g., minority communities identifiable in compact (smaller than a census block) locations, such as American Indian communities)
- any disproportionately high socioeconomic characteristic (e.g., a high dependence on pedestrian transportation).

5.6 Historic and Cultural Resources

Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA), (54 U.S.C. 300101 et seq.) requires that Federal agencies consider the effects of the agency's undertaking on historic properties included in, or eligible for, the National Register of Historic Places and, before approval of an undertaking, give the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on the undertaking. The NHPA defines "undertakings" as any project or activity that is funded or under the direct jurisdiction of a Federal agency, or any project or activity that requires a "Federal permit, license, or approval." The ACHP's regulations at 36 CFR Part 800, "Protection of Historic Properties," define the provisions for meeting Section 106 requirements.

The applicant should provide information and analysis for the U.S. Nuclear Regulatory Commission (NRC) to comply with Section 106 requirements in a manner that minimizes the potential for delays in the environmental review. The applicant should identify any activities and impacts associated with the period of plant operations, including maintenance-related and reasonably foreseeable future construction activities (e.g., warehouse, independent spent fuel storage facility), that could affect historic and cultural resources within the area of potential effects (APE) (onsite or offsite, direct and indirect effects). The applicant should provide a site utilization plan that includes the location of reasonably foreseeable future construction activities. Applicants should involve the State Historic Preservation Officer (SHPO), local historic preservation officials, and affected American Indian tribes in the assessment. The ER should include the following information (with appropriate reference to Chapter 2 of the ER to avoid duplication of information):

- Description of any operational activities including maintenance activities that could affect onsite or offsite resources (e.g., ground-disturbing activity-not discussed in Chapter 4, increases in traffic, and noise and visual intrusions (i.e., cooling towers and other plant structures)).
- Description of historic properties found in the direct and indirect APEs that will be affected by operational activities. Use the criteria specified in 36 CFR 800.5 to assess adverse effects to historic properties. Provide a basis and documentation for how a conclusion is reached.
- Description of the effects associated with operational including maintenance activities on historic and cultural resources that are not determined to be historic properties, but may be considered by

SHPO, Tribes, or members of the public to have cultural significance/importance in the context of National Environmental Policy Act of 1969, as amended (e.g., sacred sites, cemeteries, local gathering areas).

- Discuss the direct and indirect effects (e.g., ground disturbance, physical, visual, auditory, atmospheric such as fugitive dust, light, and traffic), if any, from the period of plant operations, including maintenance-related and reasonably foreseeable future construction activities (e.g., warehouse, independent spent fuel storage facility), on nearby historic properties or important historic and cultural resources.
- For indirect effects, the assessment should include drawings or modified photographs indicating the station facilities and their surroundings, if visible from these nearby important vantage points.

The assessment should lead to one of three conclusions (see 36 CFR 800.4):

- No historic properties present.
- Historic properties present but the undertaking will have no effect upon them.
- Adverse effect: The undertaking will harm one or more historic properties (see 36 CFR 800.5).

If a qualified professional has recommended a “no historic properties present” determination, then the applicant should provide supporting documentation in the ER.

If a qualified professional has recommended a finding of no adverse effect to historic properties based on the implementation of protective measures to minimize or avoid these effects, the applicant should formalize these protective measures in a protection plan in consultation with SHPO and other consulting parties and document this within the ER.

If a qualified professional determines that adverse effects to historic properties occur, the applicant should informally engage with the SHPO and affected American Indian tribes, local government, members of the public, and other affected parties and document this determination in the ER. The ER should describe any procedures and cultural resource management plans to protect historic and cultural resources during operations, as well as any measures to avoid, minimize or mitigate adverse effects. These procedures should also include steps to take in the event of inadvertent discoveries, including the discovery of human remains.

The applicant should be aware that the NRC staff will also be consulting with the SHPO, affected American Indian tribes and interested parties through the Section 106 process. If the NRC determines an adverse effect will occur, it will in accordance with Part 800 develop proposed measures in consultation with the identified consulting parties that might avoid, minimize, or mitigate such effects. Such measures, as appropriate, would be discussed in the NRC staff’s environmental impact statement (EIS). If the NRC staff determines that adverse effects exist, it can develop a Memorandum of Agreement or Programmatic Agreement (See 36 CFR Part 800), as appropriate. See Appendix B for additional information on consultation.

5.7 Air Resources

The ER should adequately describe the impacts to the atmosphere from cooling-system operations, as well as the impacts to air quality from operation of the proposed plant and associated transmission lines. The scope of the review is based on the magnitude and nature of the expected impacts associated with the operations and the characteristics of the site and vicinity.

5.7.1 Cooling-System Impacts

The applicant should describe atmospheric impacts from cooling-system operations. The description should include the following:

- type of cooling system
- cooling-system characteristics (e.g., the number of towers and fans, location, elevation above sea-level, tower physical dimensions, and release height)
- performance characteristics (e.g., air and water mass flow rates, water temperature entering and leaving the tower, air temperature leaving the tower, and amount of heat released)
- drift characteristics (e.g., drift rate, drift droplet size distributions, and concentration of dissolved and suspended solids).
- analytical technique(s) for estimating cooling-system impacts (e.g., meteorological data used)
- estimates of cooling-system impacts at the site and vicinity, including the following:
 - monthly and/or seasonal and annual plume lengths
 - monthly and/or seasonal and annual additional hours of fogging and icing
 - monthly and/or seasonal and annual amounts of salt deposition
 - monthly and/or seasonal and annual increases in humidity and precipitation, including snowfall
 - potential local weather modification from cloud formation/shadowing
 - interactions of plume with other pollutant sources

5.7.2 Air-Quality Impacts

The applicant should describe air-quality impacts associated with operations. The description should include the following:

- Identification of applicable Federal, State, and local air regulations and required air permits for operation.
- Sources and types of air pollutant emissions, including mitigating measures, and plans to minimize air emissions.
- Estimates of annual air emissions for criteria air pollutants identified in the National Ambient Air Quality Standards. If the proposed site is located in a nonattainment or maintenance area with respect to a criteria pollutant, the emission estimates can be used as a basis for assessing the applicability of a conformity analysis (see 40 CFR Part 93, Subpart B and NRC Memorandum “Revision to Staff Guidance for Conducting General Conformity Determinations” Ref. 56).

The applicant should also provide estimates of greenhouse gas (GHG) emissions (expressed in units of CO₂ equivalents), including GHG emissions from standby diesel generators and workforce transportation and comparison of these GHG emissions to state and national GHG emissions and, if available, State or Public Utility Commission GHG emission reduction goals (from Chapter 2). The applicant may provide either site-specific estimates or refer to the generic GHG footprint for a 1000-

MW(e) reactor outlined in COL-ISG-26 (Ref. 45),¹² subsequent interim staff guidance, or other regulatory guidance.

5.7.3 Transmission-Line Impacts

The applicant should describe air-quality impacts associated with transmission lines, including a description and quantification of ozone (O₃) and nitrogen oxides (NO_x) production associated with power transmission.

5.8 Nonradiological Health

The applicant should address nonradiological human health impacts of operating a new nuclear power plant. This includes a discussion of health impacts on the public and workers from operation of the cooling system, noise generated by operations, electromagnetic fields (EMFs), and transportation. In addition, the applicant should address any other sources of potential nonradiological health impacts (e.g., chemical).

5.8.1 Etiological Agents and Emerging Contaminants

The applicant should describe the operation of systems that might increase the presence and distribution of etiological agents and emerging contaminants that affect human health. These include the operation of cooling systems (e.g., release of thermal discharges into reservoirs or rivers, and cooling towers). The discussion should include the following:

- Type of cooling system, the source and discharge waterbody.
- Types of etiological agents that may be present.
- Temperature increase expected for the aquatic environment from the plant's thermal discharge. If discharge of blowdown water is to a river, the contribution of discharge to total flow and the change in water temperature should be described. Seasonal differences in temperature should also be described.
- The pathways for public and worker exposure from cooling system discharge (e.g., use of reservoir for recreational activities, collection of shellfish in thermal discharge, or workers performing cooling tower maintenance).
- Suspected contributing factors related to the incidence of disease should be discussed. Potential linkage between operation and these agents should be provided. Historical records of disease incidence should be presented.
- The potential pathways for the transfer of contaminants and materials in the reclaimed water or impaired surface waters to both the public and station workforce should be addressed. Transfer of these chemicals and compounds to members of the public and the workforce could occur as a result of maintenance and operation of the station cooling systems as well as from the disposal of sanitary wastes. Releases from the proposed facility in the form of drift or blowdown should be evaluated.

¹² Guidance in this Interim Staff Guidance (Ref. 45) will be incorporated into the next revision of NUREG-1555.

- The effect of cycles of concentration associated with the use of closed-cycle cooling on the release of chemicals and materials in the reclaimed water or impaired water sources to the public, the workforce and the environment from cooling tower drift or station blowdown.
- A discussion of State and local restrictions or requirements on the use of reclaimed or polluted water by the proposed facility.
- The effect of discharges to the environment from the sanitary waste system and its potential impact on humans should be discussed.

5.8.2 Noise Impacts

The applicant should describe noise impacts associated with operations. The description should include the following:

- background noise measurements and closest noise-sensitive receptors or sensitive areas (Chapter 2 of this RG)
- sources of noise from the proposed plant (e.g., operation of mechanical draft cooling towers and intake pumps)
- noise-abatement efforts planned for operation of the proposed plant
- expected noise levels in relation to local ordinances and/or State and Federal

5.8.3 Acute Effects of Electromagnetic Fields

The applicant should describe acute effects of electromagnetic fields associated with transmission lines. The description should include the following:

- types of transmission lines (Chapter 3 of this RG)
- types of potential exposures to transmission lines (e.g., electric shock from direct contact or induced charge to metal structures)
- impact to human health compared to national standards (e.g., National Electric Safety Code) and State and local codes and regulations

5.8.4 Chronic Effects of Electromagnetic Fields

Operating power transmission lines in the United States produce EMFs of nonionizing radiation at 60 Hz, which is considered to be an extremely low frequency (ELF)-EMF. NRC has reviewed the available scientific literature on chronic effects on human health from ELF-EMF and concurs with the conclusions of the Advisory Group on Non-Ionising Radiation (AGNIR) as stated in “Power Frequency Electromagnetic Fields, Melatonin and the Risk of Breast Cancer” (Ref. 60); by the National Institute of Environmental Health Sciences (NIEHS) as stated in “NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields” (Ref. 61); and the World Health Organization as stated in “Extremely Low Frequency Fields” (Ref. 62). The NIEHS report contains the following conclusion:

The NIEHS concludes that ELF-EMF exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as a continued emphasis on educating both the public and the regulated community on means aimed at

reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

The applicant should determine if any new and significant information relating to the effects of ELF-EMF.

5.8.5 Occupational Health

The applicant should describe human-health risks for operations personnel engaged in activities such as maintenance, testing, and plant modifications for the proposed project. The description should include the following:

- The incidence of occupational health risks described in Chapter 2 of this RG.
- Occupational health risks compared to the incidence rate for workers in similar occupations (e.g., electric power generation, transmission, and distribution). Include State and Federal labor references in the discussion.
- Standards, practices, and procedures to reduce the potential for occupational injury and fatality risk.

5.8.6 Human Health Impacts from Transportation

The applicant should provide estimates of the potential human-health impacts related to nonradiological traffic-related accidents from commuting operations and outage workers and transportation of supplies, equipment, and nonradiological waste to and from the proposed site. Nonradiological traffic-related impacts refer to the accidents, injuries, and fatalities estimated to occur from traffic accidents during movement of operations workers to and from the proposed site during operations. Where possible, the impacts should be estimated using information specific to the proposed site (e.g., by using county-specific accident statistics). The following information should be provided:

- Summary of provisions for site access during operations, including during outages.
- Description of the method(s) used to estimate nonradiological traffic-related accident impacts, including nonradiological traffic accidents, injuries, and fatalities. Nonradiological traffic-related accident impacts should be estimated using round-trip distances.
- Specification of input parameters and sources used in the impact assessment. Where assumptions are used to fill in missing or highly uncertain data (e.g., commute distances and persons per vehicle, number of deliveries), the assumptions should be bounding and reasonable (i.e., the assumptions tend to overstate transportation impacts yet are not so conservative that they could mask the true environmental impacts of the reactor and lead to invalid conclusions).
- Annual number of traffic accidents, injuries, and fatalities.
- Computer code input and output files used to estimate transportation impacts.

5.9 Radiological Health during Normal Operation

The applicant should evaluate the potential radiological impacts to the public, workers and nonhuman biota that includes the radiological sources from operation of the proposed facility. This includes a discussion of the estimated radiation dose to members of the public, workers, and to the biota inhabiting the area around the proposed site. The ER should use the same units of measure as used in the final safety analysis report (FSAR).

5.9.1 Exposure Pathways

The applicant should provide the following in the ER:

- The environmental pathways by which radiation from radioactive effluents can be transmitted from the proposed plant to living organisms. Figure 5-1 identifies the exposure pathways to humans and Figure 5-2 addresses the exposure pathways to nonhuman biota.
- The sources of direct radiation exposures. These sources should include, but not be limited to, independent spent-fuel storage installations, radioactive waste handling facilities, low-level waste storage facilities, condensate storage tanks, fuel buildings, turbine buildings, and skyshine.
- The pathways for gaseous effluents considering immersion in the gaseous plume, inhalation of iodines and particulates, ingestion of iodines and particulates through the milk cow, milk goat, meat animal and vegetation pathways, radiation from iodines and particulates deposited on the ground.
- The pathways for liquid effluents considering drinking water, ingestion of fish and invertebrates and shoreline activities for water containing radioactive effluents.
- Site-specific unusual pathways uniquely associated with the proposed facilities.

5.9.2 Radiation Doses to Members of the Public

In the ER, the applicant should provide an estimate of the maximum annual individual dose and the annual total collective doses to the population within 50-mi (80-km) from radioactive gaseous and liquid effluents released from the plant during operation. The ER should provide the inputs for these calculations as well as the source of the data used. The information in the ER should be consistent with the information in the FSAR.

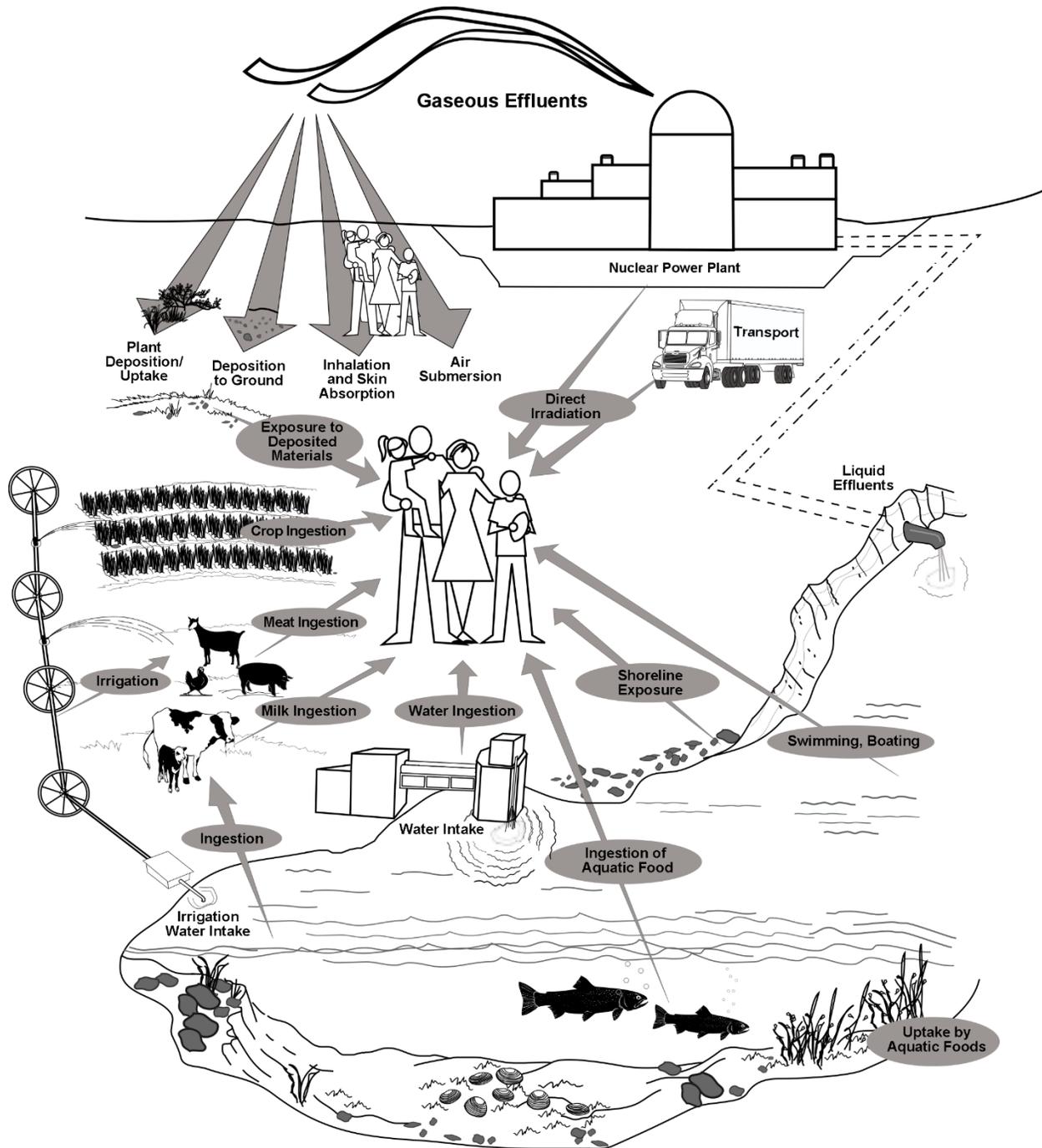


Figure 5-1. Exposure Pathways to Humans (adapted from Ref. 63)

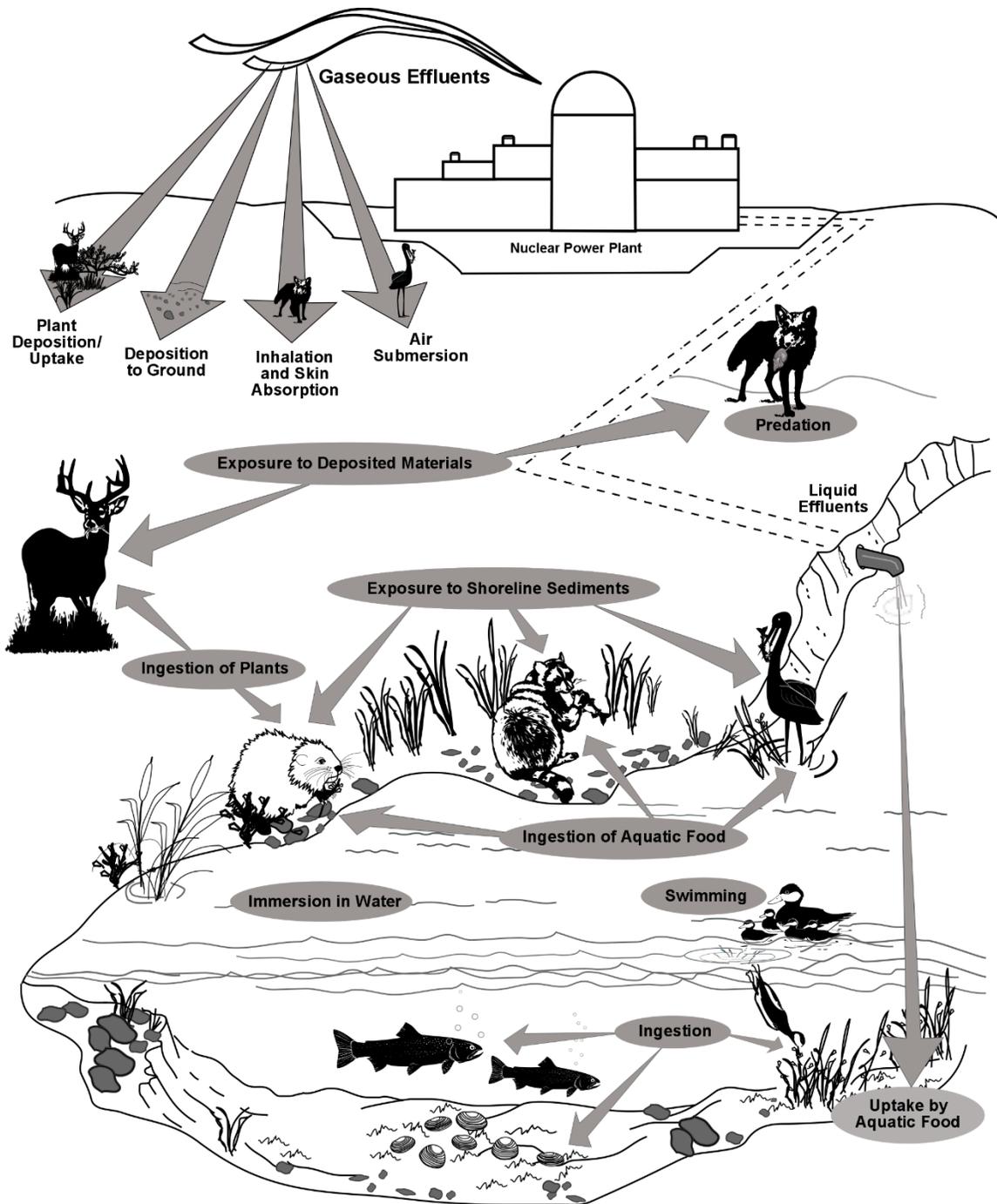


Figure 5-2. Exposure Pathways to Biota Other Than Humans (adapted from Ref. 63)

Liquid Effluent Pathway

The ER should contain the following:

- Liquid pathway doses to the maximally exposed individual (MEI) calculated using the current NRC-approved computer code (e.g., LADTAP II) (Ref. 64), that comply with RG 1.109, “Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purposes of Evaluating Compliance with 10 CFR Part 50, Appendix I” (Ref. 65). The input and output files used in the analysis should be provided to the NRC staff for confirmatory review.
- The activities considered in the dose calculations: (1) consumption of drinking water affected by liquid effluents; (2) consumption of fish and invertebrates from water sources affected by liquid effluents; (3) direct radiation from swimming, boating, and shoreline activities on waterbodies affected by liquid effluents; and (4) ingestion of irrigated foods.
- Other parameters used as inputs to the current approved computer code including effluent discharge rate, dilution factor for discharge, transit time to receptor, and liquid pathway consumption and usage factors (i.e., shoreline usage, fish consumption, and drinking water consumption).
- The location of the MEI, the age of the MEI (i.e., infant, child, teen, or adult), and source of the majority of the dose. In addition, the ER should provide the maximally exposed organ, and source of that dose.
- The calculated annual collective population doses in units of person-rem for this pathway based on an estimated population distribution late in the timeframe of the proposed license.

In the ER, the applicant should provide the doses to the MEI in a table similar to Table 5-1.

Table 5-1. Annual Doses to the Maximally Exposed Individual for Liquid Effluent Releases from the Proposed Facility

| Pathway | Age Group | Total Body (mrem/yr) | Maximum Organ (mrem/yr) | Thyroid (mrem/yr) |
|-----------------------|-----------|----------------------|-------------------------|-------------------|
| Drinking Water | Adult | | | |
| | Teen | | | |
| | Child | | | |
| | Infant | | | |
| Fish and Invertebrate | Adult | | | |
| | Teen | | | |
| | Child | | | |
| Direct Radiation | All | | | |

Source: [Provide all sources of data.]

Gaseous Effluent Pathway

The ER should contain the following:

- Gaseous pathway doses to the MEI using the currently NRC-approved computer code (e.g., GASPAR II) (Ref. 66), at the nearest residence, garden, and meat animal and the exclusion area boundary (EAB) that comply with RG 1.109. The input and output files used in the analysis should be provided to the NRC staff for confirmatory review.
- The calculated annual collective population doses in units of person-rem for this pathway based on an estimated population distribution late in the timeframe of the proposed license.
 - The following activities should be considered in the dose calculations: (1) direct radiation from immersion in the gaseous effluent cloud and from particulates deposited on the ground; (2) inhalation of gases and particulates; (3) ingestion of meat and ingestion of milk from animals eating grass affected by gases and particulates deposited on the ground; and (4) ingestion of garden vegetables affected by gases and particulates deposited on the ground.
- The gaseous effluent releases used in the estimate of dose to the MEI and population and other parameters used as inputs to the computer program should be provided (e.g., population data, atmospheric dispersion factors, ground deposition factors, receptor locations, and consumption factors).
- The doses to the MEI should be presented in a table similar Table 5-2.

Table 5-2. Doses to the Maximally Exposed Individual from Gaseous Effluent Pathway

| Pathway | Age Group | Total Body Dose (mrem/yr) | Max Organ (Specify) (mrem/yr) | Skin Dose (mrem/yr) | Thyroid Dose (mrem/yr) |
|--|------------------|----------------------------------|--------------------------------------|----------------------------|-------------------------------|
| Plume (distance and direction) | | | | | |
| Ground (distance and direction) | | | | | |
| Inhalation Nearest residence (distance and direction) | | | | | |
| Vegetable (distance and direction) | | | | | |
| Meat animals (distance and direction) | | | | | |
| Milk animals (distance and direction) | | | | | |

5.9.3 Impacts to Members of the Public

This section describes the applicant’s evaluation of the estimated impacts from radiological releases and direct radiation from the proposed facility. The evaluation should address dose from operations to the MEI located at the proposed site boundary and the population dose (collective dose to the population within 50 mi) around the proposed site.

Maximally Exposed Individual

The applicant should provide the total body and organ dose estimates to the MEI from liquid and gaseous effluents for the proposed facility and compare it to the design objectives of 10 CFR Part 50, Appendix I. A comparison of the dose estimates for the proposed facility should be presented in a table similar to Table 5-3.

For multiple units, or building of a new unit adjacent to an operating unit, the applicant should compare the combined dose estimates from direct radiation and gaseous and liquid effluents from the operating facility and the proposed facility. The data should be provided in a table similar to Table 5-4 and compared to the dose standards in 40 CFR Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations,” (Ref. 67).

Table 5-3. Comparison of MEI Annual Dose Estimates from Liquid and Gaseous Effluents to 10 CFR Part 50, Appendix I Design Objectives

| Radionuclide Releases/Dose | Applicant Assessment | Appendix I Design Objectives |
|--|-----------------------------|-------------------------------------|
| Gaseous effluents (noble gases only) | | |
| Beta air dose (mrad/yr) | | 20 |
| Gamma air dose (mrad/yr) | | 10 |
| Total body dose (mrem/yr) | | 5 |
| Skin dose (mrem/yr) | | 15 |
| Gaseous effluents (radioiodines and particulates) | | |
| Organ dose (mrem/yr) | | 15 |
| Liquid effluents | | |
| Total body dose (mrem/yr) | | 3 |
| Maximum organ dose (mrem/yr) | | 10 |

Table 5-4. Comparison of Doses to 40 CFR Part 190

| Radionuclide Dose | Operating facility | Proposed facility | Site Total dose (mrem/yr) | 40 CFR Part 190 Dose Standards (mrem/yr) |
|--|--|--|---------------------------|--|
| | Combined liquid, direct and gaseous dose (mrem/yr) | Combined liquid, direct and gaseous dose (mrem/yr) | | |
| Whole body dose | | | | 25 |
| Thyroid | | | | 75 |
| Any other organ | | | | 25 |
| Source: [Provide all sources of data.] | | | | |

Population Dose

The applicant should estimate the annual collective population total body dose in units of person-rem within a 50-mi radius of the proposed site. The estimated collective dose to the same population from natural background radiation should also be estimated and the two values compared. The dose from natural background radiation should be calculated by multiplying the 50-mi population estimate for the year operation is expected to cease (for the 40-year license including through one license renewal) by the average annual background dose rate of 311 mrem/yr from the National Council on Radiation Protection and Measurements (NCRP), “Ionizing Radiation Exposure of the Population of the United States” (Ref. 68), or the currently accepted natural background dose rate at the location being considered for the proposed site.

5.9.4 Occupational Doses to Workers

The applicant should provide an estimate for the annual occupation dose to workers, including outage activities, in units of person-rem. This value can either be estimated from the design control document (DCD) for the reactor design or from doses to workers at operational units at the site.

5.9.5 Doses to Nonhuman Biota

The applicant should determine if there is any potential for significant radiological impacts to biota other than members of the public and if so, estimate the nature and magnitude of the impact. The scope of the review should include an analysis of radiation-exposure pathways to biota.

In the ER, the applicant should include the following:

- Pathways identified in Section 5.9.1 of this RG.
- Biota to be evaluated. The biota to be considered are those species of local flora and local and migratory fauna defined as “important” (Table 2-1) and whose terrestrial and/or aquatic habitats provide the highest potential for radiation exposure or the applicant should specify surrogates for aquatic species (e.g., fish, invertebrates, and algae) and for terrestrial species (e.g., muskrats, raccoons, herons, and ducks).

- An estimation, considering exposure pathways and the distribution of facility-derived radioactivity in the environs, of the following: (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, concentration ratios, and transfer factors used in preparing the estimates should be based on site-specific data, if available; otherwise, values from the literature may be used. The applicant should tabulate and reference the values of bioaccumulation factors used in the calculations. Dose rates to important local flora and local and migratory fauna that receive the highest external exposures should be provided along with a description of the calculational models. The bioaccumulation factor for aquatic organisms is the value of the ratio: (concentration in organism)/(concentration in water). The soil-to-plant concentration ratio is the ratio of plant concentration (dry weight)/(the concentration in dry soil). The feed-to-organism transfer factor is the ratio of (concentration in fresh tissue)/(daily intake of the radionuclide by the organism). Values of bioaccumulation factors, concentration ratios, and transfer factors can be obtained from the International Atomic Energy Agency (IAEA) documents “Sediment Distribution Coefficients and Concentration Factors for biota in the Marine Environment” (Ref. 69) and “Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Terrestrial and Freshwater Environments” (Ref. 70).

The applicant should provide the doses from the liquid and gaseous pathways and the total body nonhuman biota dose from all pathways. Table 5-5 is an example of how to present the data.

Table 5-5. Nonhuman Biota Doses for Proposed Reactor(s)

| Biota | Liquid Pathway Dose (mrad/yr) | Gaseous Pathway Dose (mrad/yr) | Total Body Biota Dose All Pathways (mrad/yr) |
|---------------------------------------|--------------------------------------|---------------------------------------|---|
| Fish | | | |
| Invertebrate | | | |
| Algae | | | |
| Muskrat | | | |
| Raccoon | | | |
| Heron | | | |
| Duck | | | |
| Source: [Provide all sources of data] | | | |

The applicant should then compare the estimated total body dose rates to surrogate biota species that would be produced by releases from the proposed facility to the IAEA guidelines in “Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards” (Ref. 71) and the NCRP biota dose guidelines in “Effects of Ionizing Radiation on Aquatic Organisms” (Ref. 72). The results of the analysis should be provided in a table similar to Table 5-6.

Table 5-6. Comparison of Biota Doses from the Proposed Reactor(s) to Relevant Guidelines for Biota Protection

| Biota | Total Body Dose (mrad/d) | IAEA/NCRP Dose Guidelines for Protection of Biota Populations (mrad/d) |
|---------------------|---------------------------------|---|
| Fish | | 1000 |
| Invertebrate | | 1000 |
| Algae | | 1000 |
| Muskrat | | 100 |
| Raccoon | | 100 |
| Heron | | 100 |
| Duck | | 100 |

5.9.6 Radiological Monitoring

Regarding the radiological environmental monitoring program (REMP) for the site, the applicant should provide the following:

- The dates when the preoperational REMP began and when the operational REMP began. If the site is a greenfield site, the applicant should provide the date when the preoperational REMP is expected to start.
- A brief summary of the REMP.
- If there is an operational REMP at the site, the applicant should address whether the current REMP will be used or if there will be changes to the REMP from the addition of the proposed plant.

5.10 Nonradioactive Waste

The applicant should describe the environmental impacts that could result from the generation, handling, and disposal of nonradioactive waste during operation. The types of nonradioactive waste that would be generated, handled, and disposed of during operation include municipal solid waste, industrial solid wastes, stormwater runoff, sanitary waste, liquid effluents containing chemicals or biocides, industrial liquid wastes, used oils and lubricants from vehicle maintenance, and combustion emissions. In addition, small quantities of hazardous waste may be generated during operations.

5.10.1 Impacts to Land

The applicant should describe the expected nonradioactive waste streams destined for land-based treatment or disposal during operation. The description should include the following:

- Type of waste streams. Typical solid waste generation comes from water-treatment wastes, laboratory wastes, trash, sanitary waste, cooling-water intake screen debris, and small quantities of hazardous waste.
- Actions to address waste streams, including waste minimization, recycling, transportation, storage, and disposal.
- Federal, State, and local codes and regulations that address solid waste, including any permits necessary for solid waste at the site.

The applicant should then describe the expected impacts to land use associated with the disposal of nonradioactive waste.

5.10.2 Impacts to Water

The applicant should describe nonradioactive liquid-waste streams associated with operations. The description should include the following:

- Type of waste streams. Typical liquid-waste generation comes from cooling-water blowdown, auxiliary-boiler blowdown, water-treatment wastes, discharge from floor and equipment drains, stormwater runoff, effluents from the sanitary sewage-treatment system, and facility and vehicle maintenance activities.
- Actions to address waste streams, including waste minimization and treatment, recycling, storage, and disposal.
- Federal, State, and local codes and regulations that address liquid waste, including any permits necessary for liquid-waste disposal at the site.

The applicant should then describe the expected impacts to water resources associated with the releases of nonradioactive waste.

5.10.3 Impacts to Air

The applicant should describe nonradioactive gaseous waste streams associated with operations. Identify if these impacts have been addressed under Air Resources Impacts. The description should include the following:

- type of waste streams. Typical gaseous waste generation comes from emissions from the combustion of fossil fuels, volatile emissions from those fuels, and other volatile organic compounds from the use of materials such as paints, oils, and solvents
- actions to address waste streams, including any emission-control systems and waste minimization
- Federal, State, and local codes and regulations that address gaseous emissions. Include any permits necessary for liquid-waste disposal at the site

The applicant should then describe the expected impacts to air quality associated with the emissions of nonradioactive waste.

5.11 Environmental Impacts of Postulated Accidents

The applicant should evaluate the radiological consequences to the environment from potential accidents at the proposed site. The term “accident” refers to any off-normal event that results in the release of radioactive materials into the environment. The evaluation should be generic for design

certifications (DCs), site-specific for all other applications, and focus on events that could lead to releases substantially in excess of permissible limits for normal operations (i.e., design-basis accident (DBAs) and severe accidents). Severe accident mitigation alternatives (SAMAs) should be evaluated to determine if there are any procedures, training activities, or plant-design alternatives (i.e., severe accident mitigation design alternatives (SAMDA)) that could significantly reduce environmental risks at the site. The applicant's evaluation should be performed in accordance with the current version of NRC guidance documents, such as for the performance of cost-benefit analysis.

5.11.1 Design-Basis Accidents

The applicant should evaluate DBAs using site-specific data and realistic meteorology (i.e., 50th percentile) to estimate doses at offsite locations. Design basis accidents include a spectrum of events that the plant should be designed specifically to accommodate. The radiological consequences of the DBAs are assessed to demonstrate that the plant can be sited and operated without undue risk to the health and safety of the public. The resulting doses should be compared to relevant dose criteria used in the NRC staff's safety review of DBAs (see NURG-0800, Chapter 15). The applicant should provide the following information to support the NRC staff's environmental review of DBAs:

- list and description of each DBA being considered as having a potential for releases to the environment; the DBAs should be consistent with the DBAs listed in regulations (e.g., those described in RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants" (Ref. 73), in the DCD, and analyzed in the safety analysis report
- time-dependent isotopic activities (i.e., the source term) released to the environment for each DBA
- estimated doses for each DBA using realistic (i.e., 50th percentile) atmospheric dispersion factors (χ/Q values) for the site (see Chapter 2 of this RG), taking into account the following:
 - for the EAB, the dose should be calculated for a 2-hour period
 - for the low-population zone (LPZ), the dose should be calculated for the course of the accident (i.e., 30 days, composed of four time periods).
- comparison of the DBA doses with review criteria given in regulations (i.e., 10 CFR 52.79(a)(1), and 10 CFR 100.21, "Non-Seismic Siting Criteria") and standard review plans (i.e., SRP criteria, Table 1 in SRP Section 15.0.3 of NUREG-0800, Ref. 57).
- conclusion on the degree of environmental impact caused by postulated DBAs at this site

5.11.2 Severe Accidents

The applicant should evaluate the mean environmental (i.e., individual, population, economic, and contaminated land area) probability-weighted consequences, or risks, of severe accidents involving radioactive material within a 50 mi radius of the site. Severe accidents involve multiple failures of equipment or function and, therefore, the likelihood of occurrence is lower for severe accidents than for DBAs; however the consequences of such accidents may be higher. The risks for specific severe accident types are defined as the product of the probability of that type of accident occurring multiplied by the estimated consequences for that type of accident. Severe accident types (or major release categories), source terms, and associated probabilities (i.e., core damage frequencies) are reactor-specific and determined from the design (i.e., Level 1 and Level 2) probabilistic risk assessment (PRA).

The Level 1 and Level 2 PRAs should be consistent with the requirements of the NRC staff's safety review of PRAs (see SRP Chapter 19 of NUREG-0800 (Ref. 57)). The environmental risks of severe accidents (i.e., Level 3 PRA) should consider all severe accident types from the Level 1 PRA, apply all source terms from the Level 2 PRA, and should be generic for DCs and site-specific for all other applications. The Level 2 PRA information for the transition from radioactive material release to Level 3 PRA needs to have clear traceability of the release category quantifications back to the radioactive material release analysis. This would ensure that the necessary event information (e.g. event frequencies, source term release fractions and plume segments) from internally initiated events, fire events, flooding events, low power and shutdown events, and externally initiated events that could affect the Level 3 PRA analysis is provided in a suitable form for the NRC staff environmental review.

The risks should be estimated using an acceptable methodology that uses onsite and regional meteorology, population, and land-use data. Relevant environmental pathways that lead to radiation dose should be considered in the consequence assessment, including the air, ground, food, surface water, and groundwater. The applicant should provide the following information to support the NRC staff's environmental review of severe accidents:

- reference for the reactor design and the associated PRA (through Level 2) used in the severe accident risk analysis;
- list of severe accident release sequences and their associated core damage frequencies from the Level 1 PRA and source terms for internally initiated events, fire events, flooding events, low power and shutdown events, and externally initiated events (e.g., high winds and earthquakes) as determined from the Level 2 PRA;
- description of the methodology in NUREG/CR-6613, "Code Manual for MACCS 2: Volume 1, Users Guide," MELCOR Accident Consequence Code System (MACCS2 code) (Ref. 74 or current version) used to estimate site-specific severe accident risks (i.e., Level 3 PRA); input and output files used in the analysis should be provided to the NRC staff for confirmatory review;
- description of the meteorological data and years used in the analysis and an estimate of severe accident population dose risks from the air pathway
- description of any emergency response scenarios, including evacuation, sheltering, and dose-dependent relocation assumptions used in the analysis;
- description of the demographic and population data used in the analysis based on the 50-mi population estimate for the year operation is expected to cease;
- description of the land-use characterization (e.g., farmland) and land fractions used in the analysis and an estimate of the contaminated land area risks from severe accidents;
- description of the food pathway model information for the nuclides to be considered, crop categories to be used, transfer factors, and possible mitigative actions;
- description of the economic input data (e.g., land values, relocation costs, and cleanup costs) used in the analysis and an estimate of the economic cost risks from severe accidents;
- description of surface-water users and watershed data used in the analysis and an estimate of severe accident population dose risks from the surface-water pathway;
- description of aquifers used in the analysis and an estimate of severe accident population dose risks from the groundwater pathway;

- description of the comparison of the core damage frequencies estimated for the reactor to those for current-generation reactors and the comparison of the population dose risks to the mean and median values for current-generation reactors undergoing license renewal; and
- description of individual (i.e., early fatality and latent cancer) risks and population dose risks from severe accidents; these risks should be compared to the Commission’s Safety Goals (51 FR 30028 (Ref. 75)) and with dose risks from routine and anticipated operational releases.

NUREG/CR-4551, “Evaluation of Severe Accident Risks: Quantification of Major Input Parameters” (Ref. 76), demonstrates the development of the parameter information for the offsite environmental risk analysis of severe accidents (i.e., Level 3 PRA) that supported NUREG-1150, “Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants” (Ref. 77).

5.11.3 Severe Accident Mitigation Alternatives

The applicant should evaluate SAMAs, including procedures, training activities, and plant-design alternatives (i.e., SAMDAs), that could significantly reduce the environmental risks from a severe accident. SAMAs can reduce risk by preventing substantial core damage or by limiting radiological releases from containment in the event of substantial core damage. The current policy developed after the Limerick decision (*Limerick Ecology Action vs. NRC*, 1989, United States Court of Appeals, Third Circuit, 869 F.2d 719, 3d Cir. 1989 (Ref. 78)) requires the NRC staff to consider SAMAs in a DC environmental assessment and in a site-specific EIS for other licensing actions. Therefore, a SAMA evaluation is required in ERs for construction permits, operating licenses, combined licenses, and DCs.

In preparing SAMA analyses, the applicant should apply the latest regulatory guidance as it relates to the determination and estimation of values and impacts including sensitivity analysis (e.g., see NUREG/BR-0058, “Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission” (Ref. 79); and NUREG/BR-0184, “Regulatory Analysis Technical Evaluation Handbook” (Ref. 80)). Values are the potential benefits of implementing the SAMA and are usually calculated for public health, occupational health, offsite property, and onsite property (see the prior discussion on severe accident analyses). The applicant should apply both a 7 percent and a 3 percent real discount rate as specified by Office of Management Budget in “Regulatory Analysis” (Ref. 81), and in NUREG/BR-0058 as part of the value determination. Impacts are the costs of implementing the SAMA. In addition, the applicant could consider methods and processes used in past applications as well as relevant industry guidance on SAMA analysis (e.g., the selection of design alternatives based on NEI 05-01, Revision A, “Severe Accident Mitigation Alternatives (SAMA) Analysis, Guidance Document,” (Ref. 82)) for those situations that are relevant to the quality of the Level 2 PRA being considered in the application, including design-specific PRA information for consideration of potential design improvements under 10 CFR 50.34(f).¹³

The applicant should provide the following information to support the NRC staff’s environmental review of SAMAs:

- reference for the reactor design and the associated PRA used in the SAMA analysis;

¹³ NEI 05-01, Revision A, “Severe Accident Mitigation Alternatives (SAMA) Analysis, Guidance Document,” provides a template for completing SAMA analysis in support of reactor license renewal. If applied as a guidance document for new reactor applications, the applicant should justify its use in the ER.

- list of leading contributors to the reactor design core damage frequency (e.g., from dominant severe accident sequences or initiating events) and site-specific risks (e.g. population dose) for each release class and associated source term for both internal and external events;
- methodology, process, and rationale used to identify, screen, and select SAMAs that can reduce severe accident dose consequence risk, considering internal events, fire, flooding, low power and shutdown, and external events;
- methodology, process, and rationale used to further analyze any selected SAMAs to determine the amount of risk reduction that the SAMA could reasonably achieve;
- estimated cost, risk reduction, and value-impact ratios for the selected SAMAs and the assumptions used to make these estimates; and
- description and list of any SAMAs that have been or will be implemented to prevent or mitigate severe accidents or reduce the risk of a severe accident.

5.12 Measures and Controls to Limit Adverse Impacts during Operation

Environmental measures and controls may be required during operation to minimize effects to the environment (10 CFR 51.50(a)). The applicant should furnish details of the programs and compliance activities with which it plans to monitor operation activities affecting site-related environmental resources and quality. The applicant should also describe the frequency of these efforts. 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. A description of the measures and monitoring required for conformity to Federal, State, and local environmental regulations and laws should also be provided for each resource area. Table 5-7 on the following page is an example of the measures and controls for environmental impact categories.

Table 5-7. Summary of Measures and Controls to Limit Adverse Impacts During Operation

| Impact Category | Planned Measures and Controls During Operation |
|--|--|
| Land-Use Impacts | |
| Site and Vicinity | Measures and controls that minimize impacts |
| Transmission Corridors | Measures and controls that minimize impacts |
| Offsite Areas | Measures and controls that minimize impacts |
| Water-Related Impacts | |
| Hydrologic Alterations | Measures and controls that monitor surface waters and flow and groundwater |
| Water Use | Measures and controls that monitor use of surface and groundwater resources |
| Water Quality | Measures and controls that monitor and minimize impacts on surface and groundwater |
| Ecological Impacts | |
| Terrestrial Ecosystems | Measures and controls to monitor and minimize impacts on terrestrial resources (including wetlands) onsite, offsite, and special permitting that may be required for managed species |
| Aquatic Ecosystems | Measures and controls to monitor and minimize impacts on aquatic resources onsite, offsite, and special permitting that may be required for managed species |
| Socioeconomic Impacts | Community traffic and access to public services measures |
| Environmental Justice | Measures or controls to minimize impacts |
| Historic and Cultural Resources | Measures for identification, consultation, and preservation following discovery |
| Air Resources | Controls to monitor and minimize dust, emissions |
| Nonradiological Health | Measures and controls for worker safety during operation and maintenance activities |
| Radiation Exposure | Controls and monitoring for minimization of dose to workers, the public, and biota |
| Nonradioactive Waste | Disposal plan for solid, liquid, gaseous wastes, and sanitary waste generated |
| Accidents | Controls and measures for minimization of impacts |

Chapter 6

6.0 Fuel Cycle, Transportation, and Decommissioning Impacts

The environmental report (ER) should address the environmental impacts from the uranium fuel cycle and solid waste management, the transportation of radioactive material, and the decommissioning of the proposed nuclear plant.

The applicant should summarize information provided in Chapter 3 of this RG on the vendor and type of reactors that are proposed in the application, and the power rating in MW(t). The applicant should also provide the assumed capacity factor.

6.1 Fuel-Cycle Impacts and Waste Management

The applicant should discuss the environmental impacts from the uranium fuel cycle and solid waste management for the appropriate light water reactor (LWR) design. The environmental impacts of this design are evaluated against specific criteria for LWR designs in 10 CFR 51.51, “Uranium Fuel Cycle Environmental Data—Table S-3.”

The regulations in 10 CFR 51.51(a) state that:

Under §51.50, every environmental report prepared for the construction permit stage or early site permit stage or combined license stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S-3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating 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. Table S-3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility.

The applicant should provide the following information in the ER:

- The type of fuel and the enrichment that will be used in the proposed reactor and whether the type of fuel is appropriate for analysis of environmental impacts against Table S-3 in 10 CFR 51.51(b).
- Using the Table S-3 values that are normalized for a reference 1,000-MW(e) LWR at an 80 percent capacity factor, the applicant should provide the power rating for the each of the proposed units according to the vendor power rating and the assumed capacity factor.

In its ER, the applicant should provide an assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project based on the values given in the current Table S-3 as well as the radiological impact from radon-222 and technetium-99 as described in the License Renewal GEIS 1996, Addendum 1 (Ref. 83), and License Renewal GEIS 2013.¹⁴

6.1.1 Land Use

For the fuel cycle supporting the 1,000-MW(e) LWR-scaled model, considering the number of units, the power rating, and the capacity factor, the ER should provide the following:

- total annual land requirement;
- approximate number of acres that are permanently committed land; and
- approximate number of acres that are temporarily committed and the number of those acres undisturbed and disturbed.

6.1.2 Water Use

For the fuel cycle supporting the 1,000-MW(e) LWR-scaled model, considering the number of units, the power rating, and the capacity factor, the ER should provide the following:

- the total annual water use (in gal or m³) required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle; and
- other water uses that involve the discharge to air (e.g., evaporation losses in process cooling) in gal/yr or m³/yr and water discharged to the ground (e.g., mine drainage, deep well injection) in gal/yr or m³/yr.

6.1.3 Fossil Fuel Impacts

For the fuel cycle supporting the 1,000-MW(e) LWR-scaled model, considering the number of units, the power rating, and the capacity factor, the ER should provide the following:

- a comparison of direct and indirect consumption of electric energy for fuel-cycle operations; and
- a discussion of the largest use of electricity in the fuel cycle.

6.1.4 Chemical Effluents

For the fuel cycle supporting the 1,000-MW(e) LWR-scaled model, considering the number of units, the power rating, and the capacity factor, the ER should provide the following:

- A comparison of the principal effluents (i.e., sulfur oxides, nitrogen oxides, and particulates) for the estimated MWh of electricity for the proposed plant against the most current estimate of MWh of electricity generated in the United States. This value should be a percentage. For example, if the proposed 1000-MW(e) plant required 969,000 MWh of electricity a year and the United States produced 4.1 billion MWh of electricity in a year, then the proposed plant would

¹⁴ The License Renewal GEIS (NUREG-1437) was originally issued in 1996. Addendum 1 was issued in 1999. NUREG-1437, Revision 1, was issued in June 2013. The version cited, whether 1996 or 2013, is the version in which the relevant technical information is discussed. Revision 1 is cited in cases in which the relevant technical information is discussed in both documents.

produce 0.024 percent of the generated MWh in the United States and therefore the chemical effluents from the fuel-cycle processes to support the proposed plant would be 0.024 percent of the national gaseous and particulate chemical effluents for a year of electricity generation.

- An assessment of the liquid chemical effluents produced in the fuel-cycle processes.
- An assessment of the tailings solutions and solids generated during the milling processes.

6.1.5 Radiological Effluents

For the fuel cycle supporting the 1,000-MW(e) LWR-scaled model, considering the number of units, the power rating, and the capacity factor, the ER should provide the following:

- The estimated total overall whole body gaseous dose commitment and the whole body liquid dose commitment (in person-rem or person-sieverts) from the fuel cycle, excluding reactor releases and dose commitments because of the exposure to radon-222 and technetium-99.
- An estimate of the 100-year environmental dose commitment to the U.S. population (in person-rem or person-sieverts) for both the gaseous and liquid pathway from the fuel cycle.
- The estimated releases of radon-222 (in curies or becquerels) based on the 1996 version of the License Renewal GEIS. This includes the percent that would be from mining and milling operations, and inactive tails before stabilization, as well as the radon releases (in curies or becquerels) from stabilized tailings.
- An estimate of the 100-year dose commitment from radon-222 to the whole body (in rem or sieverts) using the organ-specific dose-weighting factors from 10 CFR Part 20, "Standards for Protection Against Radiation."
- An estimate of the 100-year dose commitment from mining, milling, and tailings before stabilization for each site year and an estimate of the 100-year environmental dose commitment from stabilized tailings piles (in rem or sieverts).
- Based on the 1996 License Renewal GEIS, an estimate of the releases of technetium-99 (in curies or becquerels) from the chemical processing of recycled UF₆ before it enters the isotope enrichment cascade and the release to the groundwater (in curies or becquerels) from a repository.
- The total body 100-year dose commitment from technetium-99 to the whole body (in rem or sieverts) determined by applying the organ-specific dose-weighting factors from 10 CFR Part 20 to the gastrointestinal tract and kidney.

6.1.6 Radiological Wastes

For the fuel cycle supporting the 1,000-MW(e) LWR-scaled model, considering the number of units, the power rating, and the capacity factor, the ER should describe the following:

- Plans for managing and shipping Class A low-level waste (LLW).
- Plans for managing and shipping Class B and C LLW if a disposal site for this LLW is available or plans to reduce the generation of Class B and C LLW or extend the capacity of onsite solid waste storage.
- Plans for managing and storing spent fuel during licensed life of the plant..

6.1.7 Occupational Dose

For the fuel cycle supporting the 1,000-MW(e) LWR-scaled model, considering the number of units, the power rating, and the capacity factor, the ER should provide the annual occupational dose attributable to all phases of the fuel cycle for the 1,000-MW(e) LWR-scaled model. This is based on a 600-person-rem occupational dose estimate attributable to all phases of the fuel cycle for the model 1,000-MW(e) LWR (see License Renewal GEIS 1996).

6.1.8 Transportation Dose

The transportation dose to workers and the public totals approximately 2.5 person-rem annually for the reference 1,000-MW(e) LWR per Table S-3. For the fuel cycle supporting the 1,000-MW(e) LWR-scaled model, considering the number of units, the power rating and the capacity factor, the ER should provide the following:

- The corresponding dose for the proposed reactor(s) (in rem or sieverts).
- The collective dose for the population within 50 mi of the site for the year operation is expected to start. Using 311 mrem/yr as the average dose to a U.S. resident from natural background radiation (NCRP Report No. 160), determine the collective dose to the same and compare the two collective doses (in person-rem or person-sieverts).

6.2 Transportation

The U.S. Nuclear Regulatory Commission (NRC) performed a generic analysis of the environmental effects of the transportation of fuel and waste to and from LWRs in the “Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants,” WASH-1238 (Ref. 84), and in Supplement 1 to WASH-1238, NUREG-75/038 (Ref. 85), and found the impact to be small. These documents provided the basis for Table S-4 in 10 CFR 51.52, “Environmental Effects of Transportation of Fuel and Waste,” which summarizes the environmental impacts of transportation of fuel and waste to and from one 3,000 to 5,000 MW(t) [1,000 to 1,500 MW(e)] LWR. Impacts are provided for normal conditions of transport and accidents in transport for a reference 1,100-MW(e) LWR. Dose to transportation workers during normal transportation operations was estimated to result in a collective dose of 4 person-rem per reference reactor-year. The combined dose to the public along the route and the dose to onlookers were estimated to result in a collective dose of 3 person-rem per reference reactor-year. Environmental risks of radiological effects during accident conditions, as stated in Table S-4, are small. Nonradiological impacts from postulated accidents were estimated as one fatal injury in 100 reference reactor-years and one nonfatal injury in 10 reference reactor-years.

The NRC has generically considered the environmental impacts of spent nuclear fuel with uranium-235 enrichment levels up to 5 percent and irradiation levels up to 62,000 MWd/MTU and found that the environmental impacts of spent nuclear fuel transport are bounded by the impacts listed in 10 CFR 51.52, Table S-4, provided that more than 5 years has elapsed between removal of the fuel from the reactor and shipment of the fuel offsite (see License Renewal GEIS 1996 and Addendum 1). However, these analyses apply to license renewal and cannot serve as the initial licensing basis for new reactors.

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

In accordance with 10 CFR 51.52(a), a full description and detailed analysis of transportation impacts are not required when licensing a LWR, if the reactor meets the following criteria:

- The reactor has a core power level that does not exceed 3,800 MW(t).
- Fuel is in the form of sintered uranium oxide pellets having a uranium-235 enrichment not exceeding 4 percent by weight; and pellets are encapsulated in zirconium alloy-clad fuel rods.¹⁵
- The average level of irradiation of fuel from the reactor does not exceed 33,000 MWd/MTU and no irradiated fuel assembly is shipped until at least 90 days after it is discharged from the reactor.
- With the exception of irradiated fuel, all radioactive waste shipped from the reactor is packaged and in solid form.
- Unirradiated fuel is shipped to the reactor by truck; irradiated (spent) fuel is shipped from the reactor by truck, railcar, or barge; and radioactive waste other than irradiated fuel is shipped from the reactor by truck or railcar.

If the transportation of fuel and waste to and from nuclear power reactors meets the criteria listed in 10 CFR 51.52(a), the ER need only contain a statement that such environmental impacts are as set forth in Table S-4 of 10 CFR Part 51. No further discussion of such environmental effects is required in the ER.

If the transportation of fuel and waste to and from nuclear power reactors does not meet the criteria listed in 10 CFR 51.52(a), a full description and detailed analysis of the environmental impacts of transportation of fuel and wastes to and from the reactor, including values for the environmental impact under normal conditions of transport and for the environmental risk from accidents in transport, is required.

6.2.1 Components of a Full Description and a Detailed Analysis of Transportation Impacts

A full description and detailed analysis of transportation impacts should include the following:

- Transportation of unirradiated fuel. The analysis should include the radiological impacts associated with the normal conditions of transport and the nonradiological impacts associated with transportation accidents.
- Transportation of irradiated fuel. The analysis should include the radiological impacts associated with the normal conditions of transport and the radiological and nonradiological impacts associated with transportation accidents.
- Transportation of radioactive waste. The analysis should include the radiological impacts associated with the normal conditions of transport and the nonradiological impacts associated with transportation accidents.

The transportation impacts analysis should use the latest versions of transportation computer codes. For example, SAND2013-8095, “RADTRAN 6/RadCat 6 User Guide” (Ref. 86), and ORNL/NTRC-006, Revision 0, “Transportation Routing Analysis Geographic Information System (TRAGIS) User’s Manual” (Ref. 87). The following data should be provided in the ER:

- reactor type and rated core thermal power
- fuel assembly description

¹⁵ Regulations in 10 CFR 51.52(a)(2) specify the use of zircaloy as the fuel rod cladding material. The NRC has also specified in 10 CFR 50.46 that ZIRLO™ is an acceptable fuel rod cladding material, and that with regard to the potential environmental impacts associated with the transportation of the M5® clad fuel assemblies, the M5® cladding has no impact on previous assessments determined in accordance with 10 CFR 51.52 (65 FR 794).

- average irradiation level of irradiated fuel
- the capacity of the onsite storage facilities to store irradiated fuel and the minimum fuel storage time between removal from the reactor and transportation offsite
- treatment and packaging procedures for radioactive wastes other than irradiated fuel
- general description of transportation packaging systems to be used for fresh fuel, spent fuel, and other radioactive wastes (e.g., packaging system capacity, approximate dimensions, and weight)
- radiation dose rates for loaded packages
- shipping route information based on the locations of fuel-fabrication facilities and potential destinations for shipments of spent fuel and radioactive waste
- transport mode for new fuel shipment to the plant
- transport mode for irradiated fuel shipments offsite
- transport mode for other radioactive waste shipments offsite
- shipping route data (e.g., distances and population densities in urban, suburban, and rural population density zones by state) from the fuel-fabrication plant to the reactor and from the reactor to the facilities to which irradiated fuel and radioactive waste will most likely be sent, if applicable
- average heat load for irradiated fuel casks in transit
- maximum gross vehicle weight for truck and rail shipments of unirradiated fuel, spent fuel, and radioactive waste

The methods and data used to estimate transportation impacts should be described and the following should be provided:

- Descriptions of the method(s) used to estimate routine (incident-free) radiological impacts, including impacts to populations and maximally exposed individuals.
- Descriptions of the method(s) used to estimate accident nonradiological and radiological impacts, including nonradiological traffic accidents, injuries, and fatalities, and radiological accident risks. Nonradiological impacts should be estimated using round-trip distances.
- Specification of input parameters and sources used in the impact assessment. Parameters and source documents should be defensible, and where assumptions are used to fill in missing or highly uncertain data, the assumptions should be conservative and reasonable (i.e., the assumptions tend to overstate transportation impacts yet are not so conservative that they could mask the true environmental impacts of the reactor and lead to invalid conclusions).
- Presentation of results, including population doses, maximally exposed individual doses, and health effects for transportation crews and the general public for the following:
 - Workers and the public under normal transport conditions. Results should be presented for workers, onlookers, and persons along the route.
 - Maximally exposed individuals under normal transport conditions. Results should be presented for truck crew members, inspectors, residents along the transport routes, and persons at a truck service station.
 - Annual radiological and nonradiological transportation impacts. Results should be presented for the proposed site.

- Computer code input and output files used to estimate transportation impacts should be provided in the ER or otherwise made available (e.g., input and output files from computer codes such as RADTRAN and TRAGIS).

6.2.2 Estimating the Number of Shipments and Normalization of Shipments

The impacts presented in Table S-4 are based on a 1,100-MW(e) LWR with an 80 percent capacity factor. To facilitate comparison of transportation impacts with the impacts presented in Table S-4, the number of shipments should be normalized to a 1,100-MW(e) LWR with an 80 percent capacity factor or a net electrical output of 880 MW(e):

$$\text{Normalized Shipments} = \frac{\text{Shipments}}{\text{Reactor MW(e)} \times \text{Capacity Factor}} \times 880 \text{ MW(e)}$$

In addition to normalizing the number of shipments to the 880-MW(e) reference reactor, for shipments of irradiated fuel, a transportation cask capacity of 0.5 MTU per shipment should be used to estimate the number of shipments. For shipments of radioactive waste, the number of shipments should be normalized to the 880-MW(e) reference reactor and a shipment capacity of 2.34 m³ per shipment should be used to estimate the number of shipments.

For shipments of unirradiated fuel, the ER should first estimate the total number of shipments over a 40-year plant lifetime, accounting for the initial core load plus average annual reloads for a period of 39 years.

$$\text{Total Shipments} = \text{Initial Core Shipments} + 39 \times \text{Average Annual Reload}$$

The number of shipments should then be normalized to the 880-MW(e) reference reactor and the annual number of shipments estimated assuming a 40-year plant lifetime.

6.3 Decommissioning

At the end of the operating life of a power reactor, NRC regulations require that the facility undergo decommissioning. The NRC defines decommissioning as the safe removal of a facility from service and the reduction of residual radioactivity to a level that permits termination of the NRC license. The regulations governing decommissioning of power reactors are found in 10 CFR 50.75, "Reporting and Recordkeeping for Decommissioning Planning" and 10 CFR 50.82, "Termination of License." The radiological criteria for termination of the NRC license are in 10 CFR Part 20, Subpart E. Minimization of contamination and generation of radioactive waste requirements for facility design and procedures for operation are addressed in 10 CFR 20.1406, "Minimization of Contamination." Requirements for applicants for a COL to provide reasonable assurance that funds will be available for the decommissioning process are given in 10 CFR 50.75(b).

The NRC has developed NUREG-0586, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors," (Decommissioning GEIS) (Ref. 88). At the time of decommissioning, if the predicted environmental impacts from decommissioning activities fall within the bounds of the GEIS or of another EIS related to the facility then no site-specific analysis will be required. For any decommissioning activity that does not meet these conditions, the regulations prohibit the licensee from undertaking the activity until it performs a site-specific analysis of the activity.

In the ER, an applicant should address the following:

- Whether the proposed reactor designs fall within the bounds of the current Decommissioning GEIS. If the proposed design is outside the design envelope evaluated in the current version of the Decommissioning GEIS, then the applicant should address how the design could affect the impact conclusions presented in the Decommissioning GEIS.
- Air-quality impacts from greenhouse gas (GHG) emissions associated with plant decommissioning (COL/ESP-ISG-26, Attachment 1).¹⁶
- The description should include the following:
 - Estimates of GHG emissions (expressed in units of CO₂ equivalents) over the decommissioning period, including GHG emissions associated with decommissioning equipment and workforce commuting. The applicant may provide either site-specific estimates or refer to the generic GHG footprint for a 1,000-MW(e) reactor outlined in COL/ESP/ISG-26, Attachment 1 or subsequent interim staff guidance or other regulatory guidance.
 - Assumptions, factors, and other information sufficient to allow an independent evaluation and assessment of the GHG emissions estimate.
- Documentation to certify that sufficient funds will be available to provide for radiological decommissioning.

¹⁶ Guidance in ESP/COL-ISG-026 will be superseded by the next revision of NUREG-1555.

Chapter 7

7.0 Cumulative Impacts

In this chapter, the applicant should describe any past, present, and reasonably foreseeable future actions in the geographic region of interest (ROI) surrounding the site that would affect the same resources that would be affected by building and operation of the proposed project, regardless of what agency or person would be responsible for such other actions. The basis for the guidance includes the following:

- 10 CFR 51.10(a) with respect to U.S. Nuclear Regulatory Commission (NRC) policy to voluntarily take account, subject to certain conditions, of the regulations of the Council on Environmental Quality (CEQ) implementing National Environmental Policy Act of 1969, as amended (NEPA). The CEQ regulations specify that an EIS discuss cumulative impacts (40 CFR 1508.25(c)(3)).
- 10 CFR 51.45 with respect to the need to discuss cumulative impacts in an environmental report (ER).
- 40 CFR 1508.25 and 10 CFR 51.14(b) with respect to the scope of an EIS and consideration of the cumulative impacts of connected, cumulative, and similar actions.

CEQ defines cumulative impact (also known as cumulative effect) in 40 CFR 1508.7 as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.” The goal of the analysis is to introduce environmental considerations into the planning process as early as needed to improve decision-making.

The ER should address the following information and analysis:

- A description of the geographic area to be considered in the evaluation of cumulative impacts for each resource area and a brief explanation of why the geographic area was selected. The geographic area may be different for each resource area, as different resources have different impact areas. The geographic area for each resource should be defined by the extent to which impacts from the project are observed and the extent to which other past, present and reasonably foreseeable future actions have or will affect the same resources.

CEQ guidance, “Considering Cumulative Effects under the National Environmental Policy Act” (Ref. 89), recommends applying natural ecological or socio-cultural boundaries. Possible geographic areas that could be used to determine the appropriate geographic area for a cumulative impact analysis are in Table 2-2 of the CEQ Guidance. The EPA guidance in EPA Publication 315-R-99-002, “Consideration of Cumulative Impacts in EPA Review of NEPA Documents” (Ref. 90), recommends that the scope include geographical areas that sustain the resources of concern, but not be extended to the point of becoming unwieldy. Geographical proximity to the proposed action should be considered but is not a decisive factor for including other actions. Jurisdictional borders are sometimes useful in defining the geographical area of interest for resource areas such as land use and some socioeconomic areas; however, this approach may not be applicable for defining the geographical area for ecological resources such as aquatic ecology. Table 7-1 provides general guidance for each resource area on appropriate geographic areas. However, professional judgment needs to be used in selecting the geographic area for a particular resource at a specific site.

Table 7-1. Geographic Area of Interest by Specific Resource

| Resource | Geographic Area of Interest |
|--|---|
| Land Use | The geographic area of interest should encompass the site, the vicinity, and the extent of offsite areas and transmission-line corridors, pipelines, and other elements of the proposed action. |
| Water Use and Quality | The geographic area of interest should reflect the use of surface and groundwater sources by the project and by other projects in proximity to the site. |
| Terrestrial Ecology | At a minimum, the geographic area of interest should encompass the site, any offsite parcels or corridors, and related segments of the surrounding landscape. The geographic area of interest should also encompass any parcels recognized early in the project design process as likely to be used for mitigation activities. A radial distance from the site, such as 6 mi (i.e., the distance used by NRC to define the project’s vicinity) may be used for terrestrial impacts, if appropriate. If one or more corridors extend farther than the selected radial distance, then the geographic area of interest should include the extended linear corridors such as transmission lines or pipelines. |
| Aquatic Ecology | A geographic area of interest could be defined according to salinity regimes, watersheds, substrate, or other environmental characteristics that define suitable habitat ranges and preferences of aquatic resources in the area affected by the project. The geographic area of interest also includes those areas (such as impoundments or facilities affecting water quality) that have or will add to the incremental effects of the project on aquatic habitats. |
| Socioeconomics and Environmental Justice | The geographic area of interest should encompass the areas of effect and the distances at which impacts of building and operating over the expected license term may occur. The scope will depend on the extent of project activities, but normally would include the site, the local community, the economic region, and demographic region identified in Chapter 2. |
| Historic and Cultural Resources | The geographic area of interest for the cumulative analysis would be the same APE(s) described in Chapters 4 and 5. |
| Air Quality | The geographic area of interest for criteria pollutants is the local/regional area and is generally the county where the licensing activity is taking place. |
| Nonradiological Health | The geographic area of interest changes based on the type of health effect. For example, acute or chronic EMF exposure is possible at the site and along the transmission corridor, whereas etiological agents are a threat in the vicinity of the thermal discharges. |
| Radiological Health | The geographic area of interest is considered to be the area that has the potential to increase radiological exposure at any location within a 50-mi radius of the proposed site. |
| Postulated Accidents | The geographic area of interest is considered to be the area that has the potential to increase risks at any location within a 50-mi radius of the proposed site. |
| Fuel Cycle, Transportation and Decommissioning | The geographic area of interest is a 50-mi radius around the site. |

The timeframe for the analysis incorporates the sum of the effects of the proposed project in combination with past, present, and future actions because impacts may accumulate or develop over time.

- Past timeframe is prior to the receipt of the application. In many cases, discussion of the past actions may entail a brief paragraph telling the story of how the resource has changed to its current condition by describing past actions and, as necessary, referring to the baseline discussion in Chapter 2 of the ER.
- Present timeframe is from the time of the application until issuance of the final EIS. The present time frame is the shortest among the three time frames and should capture any ongoing actions. Many of the resource areas measure the environment as it currently exists. These measurements capture the cumulative impact to the resource from the past and present projects and should be part of the baseline for the resource in Chapter 2 of the ER.
- Future timeframe is from issuance of the final EIS through building and operation of the proposed new unit(s) as well as decommissioning.

Future actions are those that are “reasonably foreseeable;” that is, they are ongoing (and will continue into the future), are funded for future implementation, are included in firm, near-term plans, or generally have a high probability of being implemented. In general, the baseline assessment presented in the affected environment for each resource area accounts (Chapter 2) for past and present actions. The direct and indirect impact analyses (Chapters 4 and 5) address the incremental impacts of building and operation. These analyses are referenced in this chapter and do not need to be repeated in the cumulative impact analysis.

Both the proposed project and other actions may contribute to cumulative impacts. Because cumulative impacts are additive, the analysis of cumulative impacts should concentrate only on resources that are potentially affected by past, present, and reasonably foreseeable actions as well as by building and operations activities at the proposed nuclear plant during the expected time frame of the project. Note that cumulative effects may result from the accumulation of similar effects or the synergistic interaction of different effects. The applicant should consider if the proposed action will affect the potential for each resource to sustain itself, taking into account how conditions have changed over time and how they are likely to change in the future.

7.1 Past, Present, and Reasonably Foreseeable Future Projects

For each resource area, the ER should provide a description of past and present projects, facilities, or actions that contribute to the current baseline and future status of the resource, and reasonably foreseeable future projects that could contribute to cumulative impacts to the resource during building, operation, and decommissioning of the unit(s). This description should include the following:

- project/facility/action name;
- summary description;
- location in relation to the proposed unit(s);
- status (e.g., operational, proposed, ongoing, or existing); and
- environmental resources affected.

Examples of other present or proposed actions include other electric power generation projects, chemical or paper processing facilities, bridges, roads, conservation or restoration areas, reservoirs for water storage, quarries or mines, and transmission lines. For operational projects, the applicant should

indicate whether any changes in the project are anticipated that would result in changes to the project's environmental interface.

Database tools such as those identified by the EPA in "NEPAssist Tool" (Ref. 91), can be used to identify environmental reviews and processes that have occurred or are occurring in a user-defined area of geographic interest. The applicant should discuss the resources used to identify and develop the listings of other projects and associated references, including any consultations with Federal, State, regional, and local regulators, and affected American Indian Tribes.

The ER should contain:

- a list of any EISs performed in the same geographic area as the proposed project; and
- a description of anticipated regional changes not associated with an individual project (e.g., future urbanization and climate change) that could result in cumulative impacts during building, operation, and decommissioning of the unit(s).

7.2 Impact Assessment

The applicant should provide an assessment of the level of cumulative impacts (adverse and/or beneficial) and the degree of the cumulative impacts. The applicant should summarize the principal contributor(s) to cumulative impacts for each resource area and describe the interaction between the cumulative outside stresses and those caused by building or operating the proposed project. A discussion of the incremental contribution of the activities related to the proposed action (e.g., building or operating the proposed plant) in relation to the cumulative impacts should also be included.

The ER should also include:

- any plans for mitigation of adverse cumulative impacts, or modification of alternatives to avoid, minimize, or mitigate cumulative impacts
- mitigation that may be required by Federal, State, and local authorities, including information about restoration actions by separate entities, required mitigation of other projects, or voluntary mitigation and enhancement by the entity taking an action
- at the end of the chapter a table summarizing the impact to each resource and mitigation, if any, to reduce the cumulative impact

Chapter 8

8.0 Need for Power

The Commission reaffirmed the importance of the agency's need for power analysis in a 2003 response to a petition for rulemaking (see 68 FR 55905 (Ref. 92)). The goal of the need-for-power analysis is to provide confidence that the power generated by the proposed project will be produced and consumed in a manner consistent with the stated purpose and need of the project. The analysis also provides the basis for the consideration of baseload alternative generating technologies for the proposed project. The need for power analysis should be limited to the discussion of the supply and demand for electricity. Discussion of ancillary benefits (e.g., reduced greenhouse gas emissions, fuel diversity, or grid stability) should be addressed in the benefit- cost section of the environmental report (ER).

The need for power analysis should fully describe and characterize the physical, geographic, regulatory, and administrative provisions and constraints which affect the current and forecast supply of and demand for power. The analysis should be in sufficient detail to fully demonstrate how the proposed project would supply some or all of the service area's future need for power. However, while a discussion of need for power is required, the Commission is not looking for burdensome attempts by the applicant to precisely identify future market conditions and energy demand, or to develop detailed analyses of system generating assets, costs of production, capital replacement ratios, and the like in order to establish with certainty that the construction and operation of a nuclear power plant is the most economical alternative for generation of power. The applicant should specify whether it intends to operate the proposed plant as a baseload generator, and, if so, include a discussion of the need for new baseload capacity.

The applicant should explicitly state a feasible future date for commencement of full commercial operation of the proposed project. The need for power analysis in the ER should include annual hourly peak (summer or winter, whichever is greater) and baseload demand, and total and baseload supply. The analysis should provide information over sufficient historic and projected periods to permit the staff to complete an independent assessment of the need for the power to be provided by the proposed project. The historic data should include sufficient years to identify any trends or anomalous factors that could affect the future demand for electricity. The projected period should include information out to three years beyond the planned commencement of full commercial operation of the project (referred to herein as "the analytical year").

The following sections describe the need for power analysis process in greater detail, including information needed to adequately describe the power system, power demand, power supply, and the process for assessing the need for power of the proposed project.

The applicant should identify all sources of data used in the need for power analysis in the ER and demonstrate how the data upon which the analysis relies was used. For the U.S. Nuclear Regulatory Commission (NRC) staff to rely on the analysis in the ER, the analysis should meet the following four acceptance criteria:

- **Systematic.** An analysis that has been performed according to an objective, thorough, methodical, deliberate, and organized manner and that has been presented in a step-wise fashion leading to a logical conclusion supported by the data and reasoning provided.
- **Comprehensive.** An analysis that is detailed, broad in scope, and includes a sufficient number of relevant factors so that the reviewer can reasonably conclude that the analysis may be considered "complete." The depth of analysis and discussion for each factor is commensurate with its relative importance.

- Subject to confirmation. An analysis that is independently reviewed or confirmed by another entity (e.g., Federal or State reviews of integrated resource plans, State certificate of necessity proceedings, Federal Energy Regulatory Commission reviews, or independent system operator (ISO) or regional transmission organization (RTO) reports).
- Responsive to forecasting uncertainty. A stable and robust methodology that is not unduly affected by the presence of outliers or other small departures from the modeled assumptions yet remains capable of characterizing the relative importance of uncertainty among input variables during sensitivity analyses.

The applicant may use any data and supporting information it chooses, as long as it supports an analysis that meets the NRC's four acceptance criteria. Typical sources include:

- recent demand for power reports or analyses such as annual integrated resource plans, ISO or RTO power market analyses
- state utility regulatory filings
- other regional reports or resource assessments completed by an entity other than the applicant

If analyses from external sources are not available that meet the staff's acceptance criteria, then the applicant's analyses should fully characterize the electricity market and explain how the proposed project would be used in that market. In all cases, the analyses relied upon by the applicant should meet the NRC's four acceptance criteria.

8.1 Description of the Applicant's Power Market

In developing the need for power analysis, applicants should clearly describe the specific market structure (or hybrid thereof) under which the proposed nuclear power plant would operate. Commonly recognized markets that affect a need for power analysis include:

- Rate-based utility: A rate-based utility provides generation and distribution of electricity under a regulatory obligation to provide electrical service to customers in a non-competitive market with a defined service area. The rate-based utility generally has to seek permission for expanding its fleet typically in the form of a certification from a utility oversight organization. If certification is required, the applicant should provide a detailed discussion of the status of the certification in the power market discussion.
- Merchant generator: A merchant generator produces and sells electricity into a competitive wholesale or retail power market where that electricity is administrated and delivered to the marketplace via an ISO or RTO. Development of new capacity may or may not require approval by a regulatory body. However, even if a new generating unit were to require a certification similar to that of a rate-based utility, the merchant generator's energy is not necessarily committed to a specific geographic area, does not have a captive rate base, and customers or retailers are not obligated to purchase it.

The description and details provided in this section should be consistent with the project's stated purpose and need statement from Chapter 1 of the ER. The applicant should provide the following information in the ER:

- Description of the manner in which the applicant and owners operate to supply power to the service area. This information should be consistent with information provided in the application in response to 10 CFR 50.33(d) and (i). The discussion should include any state, regional, or market-based regulatory requirements that would affect the production, distribution, and consumption of electricity. Examples include, but are not limited to, resource portfolio standards,

impacts from known or potential changes to energy-efficiency standards, and potential impacts from changes to Federal and State environmental policies.

- Detailed explanation for the selection of the intended service area for the project, including any relevant aspects of the service area which would be supported by the proposed project (e.g., proximity to load centers, shortage of available baseload capacity, portfolio diversity, etc.). The service area should be defined in terms of some readily accessible analytical area defined by the applicant's ISO, RTO, or North American Electric Reliability Corporation subregion.
- Recognized and anticipated service obligations such as power purchase agreements or any power market-based agreements deployed for stability and reliability (e.g., reserve, sharing agreements, or must-run).
- Any unique service area or market factors that may affect the accuracy or availability of current and forecast generation, transmission, and distribution of electricity. For example, grid constraints (e.g., congestion and capacity) that limit the proposed project's ability to fully service its geographic market should be identified and discussed.

8.2 Power Demand

The purpose of the power demand section is to fully disclose current and forecast demand for baseload and peak power. The level of detail provided should establish a comprehensive assessment of the existing market, and how the capacity and energy of the proposed project will be used (demanded) in that market once commissioned and operated.

This section of the need for power analysis should discuss factors which affect, or are likely to affect, the current and forecast demand for power. This commonly includes econometric, weather, and demographic data, but should also include explanations of policies and programs implemented or likely to be implemented that may influence the demand for power. Examples include, but are not limited to, discussion of energy-efficiency and conservation programs, demand-side management programs, and potential impacts from changes to energy standards and codes. The applicant should discuss any factors that could affect demand uncertainty.

Based on the description, conditions, and constraints of the relevant service area or power market provided in Section 8.1 of this RG, the applicant should provide the following information in the ER:

- historic levels of electricity demand, including:
 - annual peak demand and annual baseload demand; and
 - allocation of electricity demand disaggregated by market sectors (e.g., residential, commercial, and industrial), extending back for a period sufficient to illustrate any current trends or anomalies that affect future projections of electricity demand;
- current (as close to the application year as practicable) peak demand and baseload demand for all sectors; and
- future projections of peak demand and baseload demand, extending to the analytical year.

Demand Side Management (DSM) and Energy Efficiency (EE) programs affect demand primarily through reductions of peak and intermediate load. Any future DSM or EE should be included in the applicant's demand forecast as a reduction from annual hourly peak demand. For the purposes of a need for power analysis, the NRC staff considers reserve requirements to be a component of electricity demand; therefore, these should be included and quantified by the applicant as part of demand.

Table 8-1 provides a representative format for displaying the changes in baseload and annual peak hourly electricity demand components over the temporal scope of the analysis, noting that the analysis is not necessarily bound or limited to only these data points.

Table 8-1. Demand Forecast Summary (MW(e))

| | 20WW ^(a) | ... | 20WW | 20XX ^(b) | 20YY ^(c) | ... | 20YY | 20ZZ ^(d) |
|--|---------------------|-----|------|---------------------|---------------------|-----|------|---------------------|
| Total Baseload Demand | | | | | | | | |
| Peak Hourly System Demand | | | | | | | | |
| MINUS: DSM ^(e) and EE ^(f) | | | | | | | | |
| Total Peak Demand | | | | | | | | |
| PLUS: Reserve Margin | | | | | | | | |
| Total System Demand | | | | | | | | |
| <ul style="list-style-type: none"> - 20WW denotes data years before submittal of the application - 20XX denotes the year of submittal of the application - 20YY represents the intervening years in some useful increment - 20ZZ indicates the year three years after commencement of full commercial operations - DSM is Demand Side Management - EE is Energy Efficiency | | | | | | | | |

8.3 Power Supply

The intent of the power-supply section is to fully disclose current and forecast supply of electricity (i.e., capacity), including an analysis of installed capacity, planned capacity, and known or forecast retirements. The applicant should describe and explain the factors which affect, or are likely to affect, the current and forecast supply of electricity in the service area.

The power supply section should include a description of the regulatory, statutory, and/or business drivers, which may influence current fleet and future supply decisions. The applicant should provide any known or forecast factors that could affect uncertainty, with an emphasis on their likelihood. Examples include effects from current Federal emissions regulations; pending Federal regulations on new source review and greenhouse gas emissions; and any potential transition to alternative technologies. To the extent the proposed project addresses any of these factors they should be discussed, quantified, and aligned with the stated purpose and need.

The applicant should include the following information in the ER:

- A comprehensive assessment of the existing supply of generating capacity in the service area or power market predicated on the description, conditions, and constraints provided in Section 8.1. The existing supply of generating capacity should be disaggregated by fuel type and by dispatch (baseload, intermediate, peaking).
- All known or anticipated power purchases or sales which would serve to affect the net supply of power within the area of interest.
- All potential capacity additions, retirements, uprates, and fuel switches for the entire service area.

Recognizing not all planned capacity additions will be built and become operational, the applicant should only include “highly likely actions,” that is, projects currently under construction and/or having an issued certification of need from a utility oversight organization (e.g., a state utility commission) for the projected growth in capacity.

Table 8-2 provides a representative format for displaying the supply of power in a service area or power market over the temporal scope of the analysis, noting that the analysis is not necessarily bound or limited to only these data points.

Table 8-2. Supply Resources Summary (MW(e))

| | 20WW ^(a) | ... | 20WW | 20XX ^(b) | 20YY ^(c) | ... | 20YY | 20ZZ ^(d) |
|--|---------------------|-----|------|---------------------|---------------------|-----|------|---------------------|
| Baseload Resources | | | | | | | | |
| MINUS: Retirements | | | | | | | | |
| PLUS: Additions | | | | | | | | |
| Total Baseload Capacity | | | | | | | | |
| Installed System Capacity | | | | | | | | |
| MINUS: Retirements | | | | | | | | |
| PLUS: Additions | | | | | | | | |
| Total Installed Capacity | | | | | | | | |
| Net Transactions (exported and imported power) | | | | | | | | |
| Total System Supply | | | | | | | | |
| (a) 20WW indicates data years before the submittal of the application | | | | | | | | |
| (b) 20XX denotes the year of submittal of the application | | | | | | | | |
| (c) 20YY represents the intervening years in some useful increment | | | | | | | | |
| (d) 20ZZ indicates the year three years after commencement of full commercial operations | | | | | | | | |

8.4 Summary of the Need for Power Analysis and Conclusions

This section of the ER should provide a summary of the need for power analysis for the proposed project and disclose the applicant’s conclusions in accordance with the purpose and need definition in Chapter 1 of the ER. The findings summarized in this section should be fully substantiated by data and discussion presented in the preceding sections. This section should result in a final determination of whether or not there is a need for the power from the proposed project in the relevant service area in the analytical year.

To provide further insight into the preparation of the need for power assessment in the ER, the following descriptions delineate the types of acceptable analyses that applicants may use to make a positive determination of need. Any one of the approaches listed below is sufficient to demonstrate need for power but the applicant will need to show the basis for a positive determination of need as well as the results of the analyses outlined in Sections 8.2 and 8.3.

- **Certification of Need.** Demonstrating that the proposed action has obtained formal certification from a utility authority stating the public need for the proposed project is the most direct method for determining the need for power. Because such a certification is made by the State agency authorized to make such a determination, it is presumed to meet the four criteria. Therefore, where such regulations are in place and a certificate has been issued, further justification is not necessary. However, the applicant should include descriptions of the power market, power demand forecast, and power supply forecast, as discussed in the preceding sections. The applicant should cite the certification in the conclusions section as the basis for a positive determination of need.
- **Peak Demand Assessment.** A positive determination of peak load need can be demonstrated when the projected peak demand for electricity is greater than the projected capacity by an amount that

is greater than (or reasonably close to) the planned capacity of the proposed project in the analytical year. If the entire capacity of the proposed project cannot be accounted for in the relevant service area, the remainder may be accounted for by demonstrating the remaining capacity of the proposed project can be sold to areas outside the applicant’s relevant service area. For the relevant market area, future total system demand for electricity (including reserve requirements) should be compared to future total system supply, based on items provided in Tables 8-1 and 8-2.

- **Baseload Demonstration.** A positive determination of baseload need can be demonstrated when the projected baseload demand for electricity is greater than the projected baseload capacity by an amount that is greater than (or reasonably close to) the planned capacity of the proposed project. The applicant should include a table similar to Table 8-3 that demonstrates the need for baseload capacity greater than (or reasonably close to) the capacity of the proposed project in the analytical year.

Table 8-3. Demand and Supply Forecast Summary (MW(e))

| | 20WW ^(a) | ... | 20WW | 20XX ^(b) | 20YY ^(c) | ... | 20YY | 20ZZ ^(d) |
|---|---------------------|-----|------|---------------------|---------------------|-----|------|---------------------|
| DEMAND | | | | | | | | |
| Peak System Demand | | | | | | | | |
| MINUS: DSM and EE | | | | | | | | |
| Total Peak Demand | | | | | | | | |
| Plus Reserve Margin | | | | | | | | |
| Total System Demand | | | | | | | | |
| SUPPLY | | | | | | | | |
| Installed System Capacity | | | | | | | | |
| MINUS: Retirements | | | | | | | | |
| PLUS: Additions | | | | | | | | |
| Total Installed Capacity | | | | | | | | |
| Net Transactions | | | | | | | | |
| Total System Supply | | | | | | | | |
| Surplus (Deficit) Without the Proposed Project | | | | | | | | |
| Project Capacity | | | | | | | | |
| Surplus (Deficit) With the Proposed Project | | | | | | | | |
| <ul style="list-style-type: none"> • 20WW denotes data years before submittal of the application • 20XX denotes the year of submittal of the application • 20YY represents the intervening years in some useful increment • 20ZZ indicates the year three years after commencement of full commercial operations. | | | | | | | | |

- **Market-Based Evaluation.** A positive need for power determination need not depend on a deficit in the supply of electricity in the analytical year. Rather an applicant can demonstrate a need for power even in a market place that has a surplus of electricity. The applicant can either:
 - Perform a market-based or auction analysis describing how the applicant will price and bid their electricity to ensure the proposed project will participate in the market at levels consistent with baseload capacity factors. This approach should:
 1. describe the auction or other mechanism by which the ISO/RTO selects generators to supply power into the market, and

2. provide an analysis illustrating how the project can feasibly compete in the hourly market at a lower price than competitors, ensuring the proposed project's continuous access to the electricity market.
- Provide evidence that the proposed unit(s) intend to enter into an agreement with the ISO/RTO that in exchange for the guarantee of always being able to sell their electricity, the applicant will agree to take whatever price the ISO/RTO establishes as the hourly market price. This approach should include:
3. a description of the existing market area;
 4. a detailed description of the auction or mechanism by which generators are selected to supply power into the market; and
 5. documentary evidence of the agreement between the applicant and the ISO/RTO.

In all cases, the applicant is free to employ a need for power analysis that is not explicitly identified by the above list, provided such deviation is accompanied by a detailed explanation as to (1) why the applicant employed a different approach and (2) how the applicant's preferred methodology meets the NRC's four acceptance criteria for a need for power analysis described in this Chapter.

Chapter 9

9.0 Environmental Impacts of Alternatives

The environmental report (ER) should include a discussion of alternatives to the proposed action that is sufficiently complete to aid the U.S. Nuclear Regulatory Commission (NRC) staff in (1) discussing alternatives to the proposed action in the environmental impact statement (EIS) [National Environmental Policy Act (NEPA) Section 102(2)(C)(iii) (42 U.S.C. 4321, 10 CFR 51.45(b)(3))], and (2) developing and describing appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources (NEPA Section 102(2)(E) (42 U.S.C. 4321)). To the extent practicable, the environmental impacts of the proposal and the alternatives should be presented in comparative form (10 CFR 51.45(b)(3)).

A key aspect of the alternatives analysis is that the alternatives presented in the ER should be capable of meeting the purpose and need of the proposed project. Assume, as an example, that the purpose and need for the project includes generating approximately 1,500 MWe of baseload power by the year 2030 in the region of interest (ROI). Then an alternative that cannot generate approximately 1,500 MWe of baseload power, or cannot be in service by year 2030, or cannot effectively deliver power to the ROI, cannot meet the purpose and need and should not be retained as an alternative. For example, a given project will have its own unique purpose and need statement. Some projects may have very different statements of the purpose and need; however, any alternative that will be evaluated must meet the purpose and need.

Another key aspect of this analysis is that the alternatives presented in the ER should be reasonable¹⁷ as defined by the Council on Environmental Quality (CEQ) (46 FR 18026) (Ref. 93). In other words, there should be a reasonable expectation that the alternative could be implemented. For example, if a proposed plant requires 60 Mgd of cooling water, then an alternative site for which no such source exists or is likely to be developed is not a reasonable alternative. As another example, it is theoretically possible to generate electricity using a fusion reactor. However, as of the date of publication, commercial power generation with a fusion reactor is no closer to reality than it was 30 years ago. So fusion power is not a reasonable alternative. While these are extreme examples, they illustrate the point that to be considered an alternative, there must be a reasonable expectation that it could actually be implemented.

Except as described in Appendix A, the ER should include information on four categories of alternatives: the no-action alternative, energy alternatives, site alternatives, and system alternatives. Specific information to include in the ER is covered in the following subsections.

9.1 No-Action Alternative

The discussion of alternatives in the ER should include the no-action alternative under which the requested license or permit is not granted by the NRC. The ER should describe under the no-action alternative the impacts of not implementing the proposed action. Guidance from the CEQ states, “Where a choice of “no action” by the agency would result in predictable actions by others, this consequence of

¹⁷ Identification and evaluation of reasonable alternatives to a proposed action is the intent of NEPA: *Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant* (From the Council on Environmental Quality (CEQ) (46 FR 18026)).

the “no-action” alternative should be included in the analysis” (46 FR 18026). For example, if the proposed nuclear plant would be used to meet a demonstrated need for power, then not building the plant would lead to a failure to meet that need for power. Regulatory authorities (typically a State public service commission, or equivalent, in conjunction with any regional transmission operator and electrical reliability council) would take action to meet the need for power before the grid became unreliable. Because of this, the ER should discuss what other steps might be taken to address the need for power, and the associated environmental impacts. For example, if the likely result of the no-action alternative would be that one of the other energy alternatives would be built and operated to meet the need for power, then the ER should include that information and may refer to the discussion of that energy alternative for the associated environmental impacts.

9.2 Energy Alternatives

The first step in the discussion of energy alternatives should be to evaluate and identify the energy sources other than nuclear energy that have the potential to meet the purpose and need for the project and eliminate from detailed discussion energy sources that cannot meet the purpose and need. The second step should be to evaluate in more detail the impacts of the energy sources that can meet the purpose and need statement. Finally, the ER should compare the impacts of the energy sources that can meet the purpose and need to the impacts of the proposed project and determine if any of the alternative sources are environmentally preferable to the proposed project.

The discussion of alternatives in the ER should include all energy alternatives that could be used to meet the need for power.¹⁸ Energy alternatives can be divided into two categories; those that do not require new generating capacity (e.g., energy conservation), and those that do require new generating capacity (e.g., a natural gas-fired plant).

For alternatives that do not require new generating capacity, the ER should discuss options that go beyond any already considered in the need-for-power analysis presented in ER Chapter 8. For example, the need-for-power analysis typically has already considered energy savings associated with energy efficiency and conservation programs that the power company plans to implement. Because these programs have already been considered in the need-for-power analysis, they do not represent an alternative to the proposed action. However, for the alternatives analysis the ER should discuss the possibility of implementing additional measures (beyond those already planned) that could obviate the need for the proposed nuclear power plant. These measures may include importing more power from beyond the ROI, additional energy-efficiency, conservation, and demand-side management programs (Ref. 94),¹⁹ re-activating plants that have been retired, or extending the lives of plants that are currently assumed to retire in the need-for-power analysis. The analysis of these alternatives should consider if these alternatives are reasonable (i.e., can they meet the purpose and need of the project after considering technical and regulatory challenges). If the alternative cannot meet the purpose and need for the project then it should be eliminated from further consideration. If the alternative can meet the purpose and need then it should be retained for comparison to the proposed project.

¹⁸ As discussed in Appendix A, an applicant for an early site permit is not required to address energy alternatives (10 CFR 51.50(b)(2)). However, the applicant can choose to address energy alternatives in such an application.

¹⁹ Energy efficiency, conservation, and demand-side management programs need not be considered by the applicant if the application is for a merchant plant – a plant with no specific service territory (Ref. 94). However, if one or more other companies are implementing such programs in the ROI, the ER should include consideration of the effect of those programs on the amount of power needed.

The discussion of alternatives that would require new generation facilities should include renewable and nonrenewable sources and at least one combination of sources. Examples of renewable sources are wind, geothermal, hydroelectric, hydrokinetic (e.g., wave and tidal), biomass (e.g., wood residues), municipal solid waste, energy crops, and solar. Examples of nonrenewable sources are coal, natural gas, and petroleum fuels. A combination of alternatives is one that includes a mix of sources that are available in that region. The decision on the mix of sources in the combination should be based on consideration of maximizing the renewable portion of the combination and minimizing the environmental impacts. However, the combination must still be capable of meeting the purpose and need for the project. The analysis of alternative energy sources should consider the availability of the source in the ROI, the extent to which the source is already used in the region, and projections in the growth of the source in the region. Projections may be available from organizations such as power companies, public service commissions, Federal agencies, and universities.

Reasonable energy alternatives are those that can meet the purpose and need of the project. So, for example, if the purpose and need includes providing baseload generating capacity, then any reasonable alternative must also be capable of providing baseload generating capacity.²⁰ If a potential alternative has a capacity factor significantly lower than that of the proposed project (e.g., wind and solar), consider whether the alternative could be feasible if a form of energy storage or backup power is included. However, the feasibility and environmental impacts of energy storage or backup power would have to be included in the evaluation of the alternative.

Once reasonable alternatives have been identified, the ER should evaluate the environmental impacts of those alternatives for comparison to the impacts of the proposed action. In general, applicants should assume siting of alternative energy facilities at the proposed plant site unless the proposed site would not be suitable for the particular alternative. For alternatives that require a cooling system, the ER should assume a cooling system similar to that evaluated for the proposed project.

The environmental impacts of each reasonable alternative should be compared to the impacts of the proposed action. The ER should indicate whether any of the alternatives is environmentally preferable to the proposed action. If none of the alternatives are environmentally preferable, then no further action is needed. If any of the alternatives are found to be environmentally preferable, then the ER should determine whether such alternatives are obviously superior to the proposed action by considering other factors (e.g., cost [capital and operating costs], fuel availability, and regulatory issues). As part of the comparison of reasonable energy alternatives, the ER should compare greenhouse gas emissions associated with each alternative to the emissions from the proposed project.

9.3 Site-Selection Process

The ER should describe the process used by the applicant to identify possible sites for the new nuclear plant and to select the proposed site. The basic steps that should be described in the site-selection process are shown in Figure 9-1.

²⁰ A baseload power plant is designed to operate continuously to supply all or part of the system's minimum load (DOE/EIA's "Electric Power Industry Terms and Definitions," (Ref. 95)). Baseload power plants typically have annual load capacity factors that exceed 75 percent, but usually operate 90 to 98 percent of the time ("How to Compare Power Generation Choices" in *Renewable Energy World North America* (Ref. 96)).

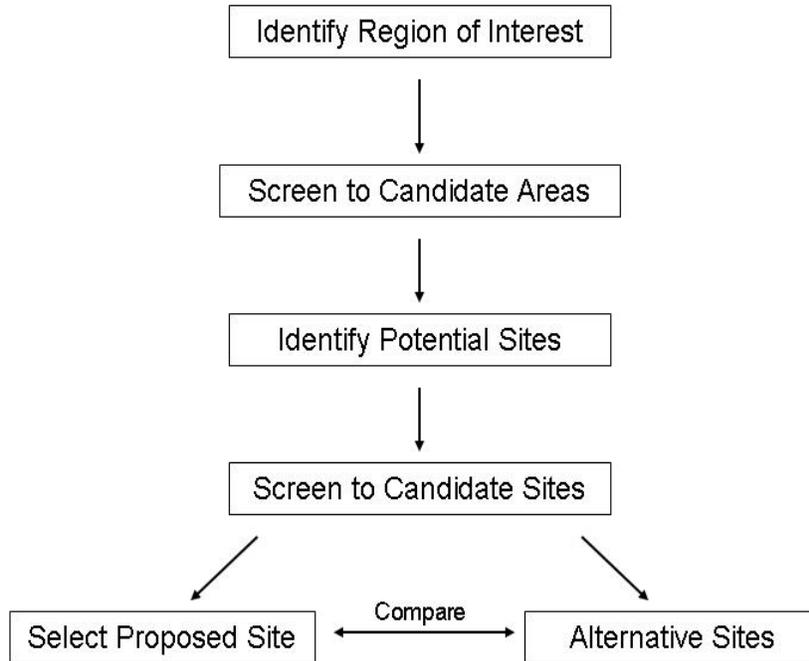


Figure 9-1. Site-Selection Process

The ER should include the following information:

- A description of the ROI, candidate areas, potential sites, and candidate sites. If any potential or candidate sites have been designated by a governmental agency as an acceptable site for a new nuclear power plant, this information should be included in the ER.
- Selection procedures for the ROI, candidate areas, potential sites, candidate sites, and the proposed site.
- The basis for establishing the geographical scope of the ROI.
- Factors considered at each level of the selection process, parameters by which these factors were measured and weighted, and criteria used to define levels of acceptability (e.g., numerical limits or decision standards).
- Methodologies used in the potential and candidate site screening process, including (when used) factors such as (1) importance factors, (2) preference functions, (3) utility functions, (4) weighting factors, (5) ranking scales, (6) scoring schemes, (7) rating systems, and (8) sensitivity analyses.
- For each alternative site, reconnaissance-level information should be included in the ER for the same impact categories used for the proposed site (see Chapters 4 and 5).

While the ER summarizes the process used to select the proposed site, the NRC staff will need to know the details of the process, which is typically described in a more detailed site-selection report prepared by or for the applicant. If such a report was prepared, it should be provided to the NRC staff at the time the application is submitted to support the staff's review.

The site-selection process should follow a logical path from the definition of the ROI; to the identification of candidate areas, potential sites, and candidate sites; to the selection of the proposed site. The ROI is the geographic area considered in searching for potential and candidate sites. The geographic

area of the ROI need not be contiguous, but if not, a logical basis for nonadjacent areas should be provided. “Candidate Areas” are one or more areas within the ROI that remain after unsuitable areas (e.g., unsuitable because of high population, lack of water, fault lines, or distance to transmission lines) have been removed. “Potential Sites” are those sites within the candidate areas that have been identified for preliminary assessment in establishing candidate sites. “Candidate sites” are those potential sites within the ROI and that are considered in the comparative evaluation of sites to be among the best that can reasonably be found for the siting of a nuclear power plant. The candidate sites include the proposed site and the alternative sites. The “proposed site” is the candidate site submitted to the NRC by the applicant as the proposed location for a nuclear power plant. “Alternative sites” are those candidate sites that are compared to the proposed site to determine if there is an obviously superior alternative site. In general, the identification of three to five alternative sites in addition to the proposed site could be viewed as adequate. Each of the steps in the process is discussed in more detail below.

9.3.1 The ROI

The ROI is typically selected based on geographic boundaries (e.g., the state in which the proposed site is located), or the relevant service area for the proposed plant. In cases where the proposed plant would not have a service area, the applicant should define a reasonable ROI and provide a justification. The ROI should be more extensive if the diversity of environmental conditions captured by the ROI would be substantially improved or if candidate sites do not meet initial threshold criteria (including the site criteria in 10 CFR Part 100, “Reactor Site Criteria” (Ref. 97)), and added geographic areas likely would not increase project costs substantially. The ER should describe how the ROI was selected, the extent of and basis for restrictions to the ROI because of siting constraints, and the extent to which the ROI is constrained based on the major load centers to be supplied by the proposed plant.

9.3.2 Candidate Areas

The ER should describe the process used to identify the candidate areas within the ROI. Reasons that areas may be unsuitable include the following:

- 10 CFR Part 100 (e.g., seismic, proximity to major centers of population density)
- lack of existing infrastructure (e.g., roads and railroads)
- lack of a suitable cooling-water source
- distance to transmission lines, substations, or load centers
- unsuitable topographic features
- potential to impact valuable agricultural, residential, or industrial areas
- potential to impact dedicated land-use areas (e.g., parks, historic sites, and wilderness areas)
- conflicts with land-use planning programs or other restrictions established by State, county, or local governments

The applicant’s process to identify candidate areas should consider these and other reasonable attributes to identify areas potentially suitable or unsuitable for siting a new nuclear power plant. The ER should present the determining characteristics of the identified areas and need not present other characteristics. For example, if an area has no suitable cooling-water source, then the area would be considered unsuitable and the other factors listed above need not be considered.

9.3.3 Potential Sites

Once the candidate areas have been identified, the ER should describe how potential sites within those areas were identified. In selecting potential sites, applicants should use a logical process that treats all sites in the same way, and would reasonably be expected to produce sites that are among the best potential sites in the candidate areas. Applicants should not use a potential site-selection process that focuses on one group or class of sites to the exclusion of other groups of sites without a defensible technical basis. The process used to identify potential sites should typically consider attributes similar to those used in the process of identifying candidate areas. However, in general this step in the process involves a somewhat more detailed look at those criteria. In addition, in many cases, the applicant can use the inverse of the attributes listed above, looking for positive rather than negative attributes. So, for example, the applicant may identify locations in the candidate areas that have ample water, are close to transmission facilities, and load centers, have infrastructure in place, etc. However, negative attributes at a specific location (e.g., seismicity or threatened and endangered species), may also be used to de-select some sites.

An applicant is not expected to conduct detailed environmental studies for potential sites; only preliminary investigations using reconnaissance-level information.²¹ A reconnaissance-level investigation should take account of information that is readily available over the Internet or from other sources (e.g., existing studies and State and Federal agencies). The applicant does not have to own the land at potential sites; however, no obvious obstruction should prevent the applicant from obtaining the land (e.g., land that is part of a National Park).

The goal of this step in the process is not to identify every potential site in the candidate areas. Depending on the size of the candidate areas, trying to identify all possible sites would yield an unworkable number of possible locations. However, the ER should demonstrate that the applicant used a logical process that would reasonably be expected to produce a list of the best potential sites in the candidate areas.

9.3.4 Candidate Sites

Candidate sites are those potential sites that are within the ROI and are considered in the comparative evaluation of sites to be among the best that can reasonably be found for the siting of a new nuclear power plant. The applicant's review of candidate sites should be directed to the identification of sites suitable for the size and type of nuclear power plant being proposed. The candidate sites include the proposed site and the alternative sites. The ER should demonstrate that the applicant's site-selection methodology resulted in the identification of candidate sites that are potentially licensable by the NRC, and among the best that can reasonably be found in the ROI. At least four candidate sites should be identified in the ER.

²¹ "Reconnaissance-level information" is defined as information that is available from the applicant, governmental, Tribal, commercial, and/or public sources. Reconnaissance-level information does not normally require the collection of new data or new field studies. Reconnaissance should include more than just a literature search for issues that are critical to the evaluation of sites. So, for example, reconnaissance should include contact with the water-management agency about water availability in most cases, as discussed in the most recent version of RG 4.7. The amount and quality of information must be sufficient based on the expert judgment of the reviewer to make the required determination for which the information is needed.

To be a candidate site, the following minimum criteria should be satisfied:

- Consumptive use of water should not cause significant adverse effects on other users.
- The proposed action should not appreciably reduce the likelihood of survival or recovery of Federal, State, or affected American Indian Tribal listed threatened, endangered, or candidate species or result in the destruction or adverse modification of critical habitat.
- There should not be any potential significant impacts to essential fish habitat or other federally protected aquatic habitats or to known spawning grounds or nursery areas of populations of important aquatic species on Federal, State, or affected American Indian Tribal lists.
- Discharges of effluents into waterways should be in accordance with Federal, State, regional, local, and affected American Indian Tribal regulations and should not adversely impact efforts to meet water-quality objectives.
- There should be no preemption of, or adverse impacts on, land specially designated for environmental, recreational, or other special purposes.
- There should not be destabilizing impacts on terrestrial and aquatic ecosystems, including wetlands that are unique to the resource area.
- There should not be other significant issues (e.g., environmental justice, historic and cultural resources, traditional cultural properties, cemeteries, burials) that preclude the use of the site.

9.3.5 Proposed and Alternative Sites

The proposed site is the candidate site identified by the applicant as the proposed location for a new nuclear power plant. Alternative sites are those candidate sites that are compared to the proposed site to determine if there is an environmentally preferable site.

The ER should provide a sufficient description of the alternative sites to allow for an evaluation of the environmental impacts of building and operating the proposed project at each site. A figure showing the proposed plant on each alternative site with the footprint and the environmental interfaces such as cooling-water intakes and discharges should be included.

The evaluation and comparison of the proposed and alternative sites should be performed for each resource area for which an assessment was performed for the proposed site, should consider cumulative impacts and be presented in tabular form. The potential impacts of climate change should be considered under cumulative impacts.

The evaluation of the cumulative impacts at the alternative sites should be similar to that for the proposed site, except that reconnaissance-level information is used for the alternative sites. If, however, initial efforts to draw a clear differentiation between the proposed site and any alternative site proves inconclusive, then reconnaissance-level information can be expanded to include information obtained through more in-depth information gathering or visits to the affected region.

An applicant can propose to build a new nuclear power plant at a site that was not selected on the basis of a systematic site-selection process (e.g., at the site of an existing nuclear power plant or a site identified by the State). In such a case, the applicant should still follow the process shown in Figure 9-1 for the selection of alternative sites. The site comparison should be performed in such a case by comparing each of the alternative sites to the proposed site.

In general, the applicant should consider the same plant design (e.g., cooling-system design and transmission-line voltage) at all of the alternative sites. However, changes to the design may be considered on a site-specific basis if the proposed design could not be used. The applicant's review should also take account of the reactor site criteria in 10 CFR Part 100 and RG 4.7.

The applicant should state in the ER whether any of the alternative sites would be environmentally preferable to the proposed site, and provide an explanation for the determination. An environmentally preferred site is a site for which the environmental impacts are sufficiently less than for the proposed site, so that environmental preference for the alternative site can be established. For any environmentally preferable site, the applicant should indicate whether it is obviously superior to the proposed site. Whereas the evaluation for an environmentally preferable site considers only environmental impacts, the determination whether a site is obviously superior also considers costs and institutional constraints.

Costs should include any additional costs associated with building and operating the proposed unit(s) at the environmentally preferable site. These costs could include items such as the cost of (1) modifying the plant design, (2) additional grading and fill, (3) ecological and cultural resource surveys, (4) the ongoing cost of establishing and operating a new emergency plan (if the proposed site already has such a plan in place), (5) the cost of obtaining the alternative site, and (6) the cost of any delay associated with changing sites. Institutional constraints could include items such as (1) known objections of regulatory agencies, (2) grid stability issues at the alternative site, (3) lack of franchise privileges and eminent domain powers, (4) the need to restructure existing financial and business arrangements, and (5) the feasibility of obtaining the alternative site. For background, see Consumers Power Co. (Midland Plant Units 1 and 2), ALAB-458, 7 NRC 155 (1978)" (Ref. 98), Public Service Company of New Hampshire et al. (Seabrook Station Units 1 and 2), ALAB-471, 7 NRC 477 (1978)" (Ref. 99); and *New England Coalition on Nuclear Pollution v. NRC*, 582 F.2d 87, (1st Cir. 1978) (Ref. 100).

If the applicant were to determine that an alternative site was obviously superior to the proposed site, then the NRC staff expects that the applicant would modify its choice of the site. If the applicant determines that an environmentally preferable site is not obviously superior to the proposed site, then the ER should explain in detail the bases for that conclusion.

If the proposed action requires an individual permit from the USACE, then USACE will perform its own analysis to determine whether the proposed site is the least environmentally damaging practicable alternative (LEDPA) using criteria in 40 CFR, Part 230, Section 404(b)(1), "Guidelines for Specification of Disposal Sites for Dredged or Fill Material" (Ref. 101). While the USACE evaluation of the LEDPA site, and the NRC staff's evaluation as to whether there is an obviously superior alternative site considers similar factors, there are some differences in the focuses of the two evaluations. Regardless, experience has shown that early coordination with the USACE on issues related to siting and LEDPA, will reduce the likelihood of significant problems and delays during the review. In addition, because the NRC staff and USACE staff will both review the information in the applications to the NRC (the ER) and the USACE, the applicant should ensure that the information provided in these documents is consistent.

The following sections describe the specific resource area information that should be provided for each alternative site. The impacts described in Chapter 6 of the ER (e.g., nuclear fuel cycle, decommissioning), would not vary significantly from one site to another. Typically, all of the alternative sites and the proposed site are in low-population areas, and the review team assumes the same reactor plant design is applicable for each of the sites. Therefore, the same fuel cycle technology, transportation methods, and decommissioning methods would be used. Because of this, these impacts would not differentiate between the sites and would not be useful in the determination of whether an alternative site

is environmentally preferable to the proposed site. For this reason, these impacts are not discussed in the evaluation of the alternative sites.

Similarly, the nonradiological waste impacts described in Chapters 4, and 5 would not vary significantly from one site to another. The types and quantities of nonradiological waste would be about the same at any of the alternative sites. For each alternative site, all wastes destined for land-based treatment or disposal would be transported offsite by licensed contractors to existing, licensed disposal facilities operating in compliance with all applicable Federal, State, and local requirements. All nonradioactive liquid discharges would be discharged in compliance with the provisions of an applicable NPDES permit. Also, the amount of nonradioactive, nonhazardous municipal solid waste to be generated annually by the plant would be a relatively small percentage of the total solid waste generated within the geographic area of influence of any of the alternative sites.

Cumulative Impacts

The applicant should provide a description of any past, present, and reasonably foreseeable future actions in the general area surrounding the alternative sites that would affect the same resources impacted by the proposed units as was prepared for the preferred site (Section 7.0 of this RG). The applicant should use the same approach to establish the geographic area of interest for each resource area as described in Table 7-1.

Land Use

The characterization and discussion of possible land-use impacts should follow the same guidance used in Chapters 2, 4, 5, and 7 of this RG, using reconnaissance-level information.

Hydrology

A reconnaissance-level discussion of surface-water and groundwater features, and availability should be made using available water-management-agency information, aerial photographs, maps, and geographic information system (GIS) layers, if available. The characterization and discussion of possible effects to surface-water and groundwater should follow the same guidance used in Chapters 2, 4, 5, and 7 of this RG, using reconnaissance-level information.

Terrestrial Ecology

A reconnaissance-level baseline characterization of terrestrial resources on alternative sites can be expected to rely heavily on aerial photographs, maps, and GIS layers published by Federal and State natural resource management agencies. The characterization and discussion of possible impacts should follow the same guidance used in Chapters 2, 4, 5, and 7 of this RG, using reconnaissance-level information. Adequate information on the possible occurrence of important species and habitats can be obtained from discussions with, or online databases maintained by, the Fish and Wildlife Service (FWS), and State natural heritage programs.

Aquatic Ecology

A reconnaissance-level baseline characterization of aquatic resources on alternative sites can be expected to rely heavily on aerial photographs, maps, and GIS layers published by Federal and State natural resource management agencies. The characterization and discussion of possible impacts should follow the same guidance used in Chapters 2, 4, 5, and 7 of this RG, using reconnaissance-level information. Adequate information on the possible occurrence of important species and habitats can be

obtained from discussions with, or online databases maintained by, the FWS, National Marine Fisheries Service, and State natural heritage programs. Guidance on sources and use of aquatic reconnaissance level information for alternative sites is found in RG 4.24.

Socioeconomics

If a socioeconomic topic is important enough for a discussion in the proposed site analysis, that same topic should be considered for each alternative site. Demographic data for each alternative site should be provided by the applicant at the same level of detail as that presented for Chapters 2, 4, 5, and 7 of this RG, including any maps and summary tables. The characterization and discussion of other impact areas should be performed using reconnaissance-level information.

Environmental Justice

If an environmental justice topic is important enough for a discussion in the proposed site analysis, that same topic should be considered for each alternative site. The Census block group assessment of demographic data for each alternative site should be provided by the applicant at the same level of detail as that presented for Chapters 2, 4, 5, and 7 of this RG, including any maps and summary tables. The characterization and discussion of other impact areas should be performed using reconnaissance-level information.

Historic and Cultural Resources

Applicants should provide reconnaissance-level information on historic and cultural resources for each of the alternative sites being considered. There is a difference between reconnaissance-level information and reconnaissance activities. The applicant should gather information on known historic and cultural resources at the alternative sites, and within the vicinity through a comprehensive literature review. Survey and site information (e.g., historic and cultural resources that are listed on or eligible for the National Register of Historic Places) should be obtained through the State Historic Preservation Office, as well as local historical societies within the vicinity of the alternative site locations, and GIS tools (e.g., NEPAassist).

Because detailed cultural resource field investigations are not generally performed on alternative sites, there is uncertainty about the direct or indirect effects on historic and cultural resources that may or may not be located at or in the vicinity of the alternative site. The applicant should, when determining impacts, base them on known resources and the probability of the area containing resources. For example, if an adjacent area has been surveyed and resources have been found or in the opinion of the qualified professional there are likely to be resources located on the site then that information should be considered in determining the impact level. The characterization and discussion of possible impacts should follow the same guidance used in Chapters 2, 4, 5, and 7 of this RG, using reconnaissance-level information with the exception that the NRC does not perform National Historic Preservation Act (NHPA) consultation for alternative sites.

Air Quality

Applicants should provide reconnaissance-level information related to air quality for the region around each alternative site. For criteria pollutants, this is the local/regional area and is generally the county in which the alternative site is located. The characterization and discussion of possible impacts should follow the same guidance used in Chapters 2, 4, 5, and 7 of this RG, using reconnaissance-level information.

Nonradiological Health

Applicants should provide reconnaissance-level information for the region around each alternative site. The characterization and discussion of possible impacts should follow the same guidance used in Chapters 2, 4, 5, and 7 of this RG, using reconnaissance-level information.

Radiological Health

Applicants should provide reconnaissance-level information for the region around each alternative site. The characterization and discussion of possible impacts should follow the same guidance used in Chapters 2, 4, 5, and 7 of this RG, using reconnaissance-level information.

Postulated Accidents

The applicant should evaluate the impacts of postulated accidents at alternative sites using a qualitative analysis to characterize and discuss possible impacts as in Chapters 5 and 7 of this RG.

9.4 System Alternatives

The ER should include information on system design alternatives for the heat-dissipation and circulating-water systems. Specific information to include in the ER is covered in the following subsections.

9.4.1 Heat Dissipation

The applicant should discuss alternatives to the proposed heat-dissipation system at the proposed site. Alternatives that should be considered include once-through cooling, mechanical draft wet cooling towers, natural draft cooling towers (including fan assisted towers), wet/dry cooling towers, dry cooling towers, cooling ponds, and spray ponds. The applicant should assess, and document in the ER, whether each alternative (1) is feasible and practical given conditions at the proposed site, and (2) could meet the requirements of Section 316 of the Federal Water Pollution Control Act, and associated Federal and State implementing regulations. For alternatives which satisfy those two criteria, information should be included in the ER that compares the environmental impacts of the proposed heat-dissipation system with the alternative system(s). If an alternative system is found to be environmentally preferable to the proposed system, comparative information on the estimated capital and operating cost of the proposed system vs. the estimated capital and operating cost of the environmentally preferable system should be included in the ER. The applicant should state the basis for choosing the proposed system over the environmentally preferable system.

9.4.2 Circulating-Water System Alternatives

The applicant should discuss alternatives to the proposed circulating-water system at the proposed site. The evaluation should address alternatives for the intake, discharge, water-supply, and water-treatment portions of the system. Applicants should assess, and document in the ER, whether each alternative (1) is feasible and practical given conditions at the proposed site, and (2) could meet the requirements of Section 316 of the Federal Water Pollution Control Act, and associated Federal and State implementing regulations. For alternatives which satisfy those two criteria, information should be included in the ER that compares the environmental impacts of the proposed system with the alternative system(s). If an alternative system is found to be environmentally preferable to the proposed system, comparative information on the estimated capital and operating cost of the proposed system vs. the estimated capital and operating cost of the environmentally preferable system should be included in the

ER. The applicant should state the basis for choosing the proposed system over the environmentally preferable system.

9.4.3 Other System Alternatives

In unusual circumstances, an applicant may find that consideration of alternatives for other portions of system designs (e.g., the cooling system specific to the service water system) may be warranted. In such cases, the applicant should develop and compare appropriate alternatives and describe its basis for selecting the proposed system.

Chapter 10

10.0 Conclusions

10.1 Impacts of the Proposed Actions

The applicant should summarize and reference the impacts of the proposed action from Chapters 4, 5, and 7.

10.2 Unavoidable Adverse Environmental Effects

As required by 10 CFR 51.45(b)(2), an environmental report (ER) shall discuss “Any adverse environmental effects which cannot be avoided should the proposal is implemented.” Unavoidable adverse environmental impacts are those impacts of the U.S. Nuclear Regulatory Commission (NRC) action and the U.S. Army Corps of Engineers (USACE) action (if it is a cooperating agency), that cannot be avoided in the use of the site and associated offsite facilities. The applicant should provide two tables listing the resource area, impacts, mitigation measures, and the unavoidable adverse impacts left after mitigation. One table should list the unavoidable adverse impacts from building, and the other should list the unavoidable adverse impacts from operation.

10.3 Relationship between Local Short-Term Use of the Environment and Long-Term Productivity

As required by 10 CFR 51.45(b)(4), an ER shall discuss “The relationship between local and short-term uses of man’s environment and the maintenance and enhancement of long-term productivity.” The short-term uses of the human environment by the proposed project can be summarized in terms of the unavoidable adverse environmental impacts of building and operation and the irreversible and irretrievable commitment of resources. The applicant should describe the principle short-term benefit of the project (typically, the production of electricity) against the long-term uses of the site (agriculture or other probable uses of the site).

10.4 Irreversible and Irretrievable Commitments of Resources

As specified by 10 CFR 51.45(b)(5), an ER shall discuss “Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.” The term “irreversible commitments of resources” refers to environmental resources that would be irreparably changed by the building or operation activities authorized by the NRC or USACE (if a cooperating agency) permit and licensing decisions, where the environmental resources could not be restored at some later time to the resource’s state before the relevant activities. The term “irretrievable commitments of resources” refers to materials that would be used for or consumed by the new units in such a way that they could not, by practical means, be recycled or restored for other uses. The applicant should discuss the irreversible and irretrievable commitment of resources for each resource area in Chapters 4, 5 and 6. The applicant should indicate if there is no irreversible or irretrievable commitment of resources for a particular resource area.

10.5 Alternatives to the Proposed Action

As specified by 10 CFR 51.45(b)(3), an ER shall discuss “Alternatives to the proposed action.” The applicant should summarize and reference the Chapter 9 analysis of the alternatives to the proposed action.

10.6 Benefits and Costs

As required in 10 CFR 51.45(c), the ER should include information on the estimated benefits and costs associated with the applicant's proposed project. The NRC staff will review this information and use it, as deemed appropriate, in the NRC staff's balancing of the costs (including environmental costs) against the anticipated benefits of the proposed action. To the extent possible, the estimated benefits and costs should be quantified. For all qualified and quantified benefit and cost categories, the applicant should provide a discussion commensurate with the importance of the category to the application process.

The applicant should provide separate tabular summarization of the benefits and the costs of the proposed action. This information will be gleaned from building and operations impacts (i.e., Chapters 4, 5, and 7), the analysis of need for power (i.e., Chapter 8), and the alternatives analysis (i.e., Chapter 9). Benefits and costs should be quantified to the extent practicable and presented using standard units for the domain of the resource being quantified (e.g., dollars, acres, and kWh).

10.6.1 Benefits

The ER should include information on the estimated benefits of the proposed project in accordance with the project's stated purpose and need (i.e., Chapter 1). Benefits can include, but are not limited to the following:

- net electrical generating benefits of the proposed plant
- fuel diversity in the generation fleet
- State or public utility commission GHG emission goals and how the project contributes to the goal
- energy independence and national security
- price stabilization and reduction
- demonstration of technological capabilities
- compliance with environmental regulations and the reduction of air pollution (e.g., criteria, hazardous, and greenhouse gas emissions)
- by-production of other commercial products (e.g., steam)
- expected annual tax payments to local and State governments for the building period and during operation of the proposed plant
- any estimated incremental increase in regional productivity during building and operating period
- any nonmonetary benefits (e.g., new recreational facilities and improved road conditions)

10.6.2 Costs

The ER should include information on the estimated internal and external costs of building- and operations-related activities. The negative environmental impacts described in the ER may be expressed as external or societal costs and should be quantified in the units appropriate to the resource domain estimating the impact.

Financial costs help the public evaluate the financial benefits of the proposed project in light of its costs. The applicant should provide the same level of cost information to the NRC as would typically be

provided to other regulators (e.g., utility commissions). At a minimum, the following internal financial cost information should be provided:

- Overnight capital cost of the proposed action, including the following:
 - all building activities at the site and offsite areas
 - acquisition and placement of all plant structures and components
 - installation of transmission lines, pipelines, access routes, rail spurs, and other utility corridors
- Financing and other costs, including the following:
 - expected financing costs including provisions for the allowance for funds used during building
 - other costs the applicant will be required to disclose to other regulators to provide a complete picture of the financial cost of the project
- Operations costs, including the following:
 - fuel costs
 - plant operations and maintenance costs including maintenance and outage costs
 - waste disposal and plant decommissioning costs
 - additional regulatory compliance costs, taxes, fees, and environmental costs
 - other costs the applicant will be required to disclose to other regulators to provide a complete picture of the financial cost of the project

10.6.3 Benefit-Cost Balance

A key component of the applicant's ER will be comparison of benefits and costs for the proposed action. The applicant should clearly enumerate and explain how the benefits of the proposed action outweigh the expected internal and external costs.

Chapter 11

Reference Guidance

The applicant should provide a bibliography of sources used in preparation of the environmental report (ER). References should be cited and listed at the end of the chapter to which they refer. The applicant should have all reference material used in the ER available for the U.S. Nuclear Regulatory Commission staff's review.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees²² may use this regulatory guide (RG) and information about the U.S. Nuclear Regulatory Commission's (NRC's) plans for using this RG. In addition, this section describes how the NRC staff complies with 10 CFR 50.109, "Backfitting," and any applicable finality provisions in 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

Use by Applicants and Licensees

Applicants and licensees may voluntarily²³ use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described in this RG may be deemed acceptable if they provide sufficient basis and information for the NRC staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations. Current licensees may continue to use guidance the NRC found acceptable for complying with the identified regulations as long as their current licensing basis remains unchanged.

Licensees may use the information in this RG for actions which do not require NRC review and approval (e.g., changes to a facility design under 10 CFR 50.59, "Changes, Tests, and Experiments"). Licensees may use the information in this RG or applicable parts to resolve regulatory or inspection issues.

Use by NRC Staff

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this RG. The NRC staff does not expect any existing licensee to use or commit to using the guidance in this RG, unless the licensee makes a change to its licensing basis. The NRC staff does not expect or plan to request licensees to voluntarily adopt this RG to resolve a generic regulatory issue. The NRC staff does not expect or plan to initiate NRC regulatory action which would require the use of this RG. Examples of such unplanned NRC regulatory actions include issuance of an order requiring the use of the RG, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to use of this RG, generic communication, or promulgation of a rule requiring the use of this RG without further backfit consideration.

During regulatory discussions on plant-specific operational issues, the staff may discuss with licensees various actions consistent with staff positions in this RG, as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions would not ordinarily be considered backfitting even if prior versions of this RG are part of the licensing basis of the facility. However, unless this RG is part of the licensing basis for a facility, the staff may not represent to the licensee that the licensee's failure to comply with the positions in this RG constitutes a violation.

²² In this section, "licensees" refers to licensees of nuclear power plants under 10 CFR Parts 50 and 52; and the term "applicants," refers to applicants for licenses and permits for (or relating to) nuclear power plants under 10 CFR Parts 50 and 52, and applicants for standard design approvals and DCs under 10 CFR Part 52.

²³ In this section, "voluntary" and "voluntarily" means that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

If an existing licensee voluntarily seeks a license amendment or change and (1) the NRC staff's consideration of the request involves a regulatory issue directly relevant to this revised RG and (2) the specific subject matter of this RG is an essential consideration in the staff's determination of the acceptability of the licensee's request, then the staff may request that the licensee either follow the guidance in this RG or provide an equivalent alternative process that demonstrates compliance with the underlying NRC regulatory requirements. This is not considered backfitting as defined in 10 CFR 50.109(a)(1) or a violation of any of the issue finality provisions in 10 CFR Part 52.

In addition, an existing applicant may be required to comply to new rules, orders, or guidance if 10 CFR 50.109(a)(3) applies.

If a licensee believes that the NRC is either using this RG or requesting or requiring the licensee to implement the methods or processes in this RG in a manner inconsistent with the discussion in this section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in NRC Management Directive 8.4, "Management of Facility-Specific Backfitting and Information Collection" (Ref. 102), and NUREG-1409, "Backfitting Guidelines" (Ref. 103).

REFERENCES²⁴

1. *U.S. Code of Federal Regulations* (CFR), “Domestic Licensing of Production and Utilization Facilities,” Part 50, Title 10, “Energy.”²⁵
2. CFR, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Part 52, Title 10, “Energy.”
3. CFR, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” Part 51, Title 10, “Energy.”
4. National Environmental Policy Act of 1969 (NEPA), as amended, 42 United States Code (U.S.C.) 4321 et seq.²⁶
5. Executive Order 11514, “Protection and Enhancement of Environmental Quality.” *Federal Register*, 35 FR 4247. March 5, 1970, Office of the President, Washington, DC.²⁷
6. Executive Order 11991, “Environmental Impact Statements,” *Federal Register*, 42 FR 26967. May 25, 1977, Office of the President, Washington, DC.
7. CFR “Chapter V – Council on Environmental Quality - Index to Parts 1500 Through 1508,” Parts 1500 - 1508, Title 40, “Protection of Environment.”
8. Atomic Energy Act of 1954, 42 U.S.C. 2011 et seq.
9. Energy Reorganization Act of 1974, as amended, 42 U.S.C. 5801 et seq.
10. U.S. Nuclear Regulatory Commission (NRC), RG 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition),” Washington, DC.
11. NRC, RG 4.7, “General Site Suitability Criteria for Nuclear Power Stations,” Washington, DC.

²⁴ All NRC documents that are publicly available may be accessed through the Electronic Reading Room on the NRC’s public Web site at: <http://www.nrc.gov/reading-rm/doc-collections/>. The documents can also be viewed online or printed for a fee in the NRC’s Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone 301-415-4737 or 800-397-4209; fax 301-415-3548; and e-mail pdr.resource@nrc.gov.

²⁵ The Code of Federal Regulations may be obtained electronically from the U.S. Government Printing Office at: <http://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR>

²⁶ The United States Code (USC) can be obtained electronically from the Office of the Law Revision Counsel of the House of Representatives at <http://uscode.house.gov/>.

²⁷ Publicly available executive orders and similar documents may be obtained through the National Archives and Records Administration at their Web site (<http://www.archives.gov/>), by telephone (1-866-272-6272), fax (301-837-0483), or U.S. Mail at The National Archives and Records Administration, 8601 Adelphi Rd., College Park, MD 20740-6001.

12. NRC, RG 4.11, “Terrestrial Environmental Studies for Nuclear Power Stations,” Washington, DC.
13. NRC, NUREG-1555, “Environmental Standard Review Plan: Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan,” Washington, DC.
14. NRC, COL/ESP-ISG-026, “Environmental Issues Associated with New Reactors Interim Staff Guidance,” Washington, DC (ADAMS Accession No. ML14092A402).
15. NRC, COL/ESP-ISG-027, “Specific Environmental Guidance for Light Water Small Modular Reactor Reviews,” Washington DC (ADAMS Accession No. ML14100A648).
16. International Atomic Energy Agency (IAEA), 2013. “Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes,” IAEA Nuclear Energy Series No. NG-T-3.11.²⁸
17. IAEA, 2016, “Site Evaluation for Nuclear Installations,” Safety Standards Series NS-R-3, Vienna, Austria.
18. Endangered Species Act of 1973, 16 U.S.C. 1531 et seq.
19. Magnuson-Stevens Fishery Conservation and Management Act of 1996, 16 U.S.C. 1801 et seq.
20. National Historic Preservation Act of 1966, 54 U.S.C. 300101 et seq.
21. Fish and Wildlife Coordination Act of 1934, as amended, 16 U.S.C. 661-667 et seq.
22. Federal Water Pollution Control Act of 1972 (also referred to as Clean Water Act), 33 U.S.C. 1251 et seq.
23. Clean Air Act of 1970, 42 U.S.C. 7401 et seq.
24. Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et seq.
25. Nuclear Energy Institute (NEI). 2013. “Industry Guideline for Effective Pre-Application Interactions with Agencies Other Than NRC during the Early Site Permit Process,” NEI 10-07, Revision 1 (ADAMS Accession No. ML13028A392).
26. NRC, Memorandum from Scott Flanders (NRC) to Rodney McCullum (NEI), “Endorsement of Nuclear Energy Institute 10-07, Revision 1, Industry Guideline for Effective Pre-Application Interactions with Agencies Other than the U.S. Nuclear Regulatory Commission during the Early Site Permit Process,” March 12, 2013, Washington, DC (ADAMS Accession No. ML13035A067).
27. NRC, “Limited Work Authorizations for Nuclear Power Plants.” *Federal Register*, 72 FR 57416. October 9, 2007, Washington, DC.

²⁸ Copies of International Atomic Energy Agency (IAEA) documents may be obtained through their Web site: WWW.IAEA.Org/ or by writing the International Atomic Energy Agency P.O. Box 100 Wagramer Strasse 5, A-1400 Vienna, Austria. Telephone (+431) 2600-0, Fax (+431) 2600-7, or E-Mail at Official.Mail@IAEA.Org.

28. CFR, “Physical Protection of Plants and Materials,” Part 73, Title 10, “Energy.”
29. U.S. Army Corps of Engineers (USACE) and U.S. Nuclear Regulatory Commission (NRC). 2008. “Memorandum of Understanding between U.S. Army Corps of Engineers and U.S. Nuclear Regulatory Commission on Environmental Reviews Related to the Issuance of Authorizations to Construct and Operate Nuclear Power Plants.” Washington, DC (ADAMS Accession No. ML082540354).
30. NRC, NUREG–2157, “Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel. Final Report,” 2014, Washington, DC (ADAMS Accession Nos. ML14196A105 and ML14196A107).
31. CFR, “Prime and Unique Farmlands,” Part 657, Title 7, “Agriculture.”
32. CFR, “Definitions of Waters of the United States,” Part 328, Title 33, “Navigation and Navigable Waters.”
33. U.S. Fish and Wildlife Service (FWS), 2014, “National Wetlands Inventory,” Falls Church, VA.²⁹
34. NRC, RG 4.24 “Aquatic Environmental Studies for Nuclear Power Stations,” Washington, DC.
35. Executive Order 12898: “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” *Federal Register*, 59 FR 7629, February 16, 1994, Office of the President, Washington, DC.
36. NRC, Office Instruction LIC-203, Revision 3, “Procedural Guidance for Preparing Categorical Exclusions, Environmental Assessments, and Considering Environmental Issues,” 2013, Washington DC (ADAMS Accession No. ML12234A708).
37. NRC, 1998, “In the Matter of Louisiana Energy Service Claiborne Enrichment Center,” Docket 70-3070-ML020560604, CLI-98-3, Washington, DC, April 3, 1998.
38. NRC, NUREG-1939, “Final Environmental Impact Statement for Combined Licenses for Virgil C. Summer Nuclear Station, Units 2 and 3,” Volumes 1 and 2, Washington, DC (ADAMS Accession Nos. ML11098A044 and ML11098A057).
39. CFR, “National Register of Historic Places,” Part 60, Title 36, “Parks, Forests, and Public Property.”
40. CFR, “Protection of Historic Properties,” Part 800, Title 36, “Parks, Forests, and Public Property.”
41. CFR, “Professional Qualification Standards,” Part 61, Title 36, “Parks, Forests, and Public Property.”
42. NRC, RG 1.23, “Meteorological Monitoring Programs for Nuclear Power Plants,” Washington, DC.
43. CFR, “Designation of Areas for Air Quality Planning Purposes,” Part 81, Title 40, “Protection of Environment.”

²⁹ Accessible from the U.S. Fish and Wildlife Service web site: <http://www.fws.gov/wetlands/>.

44. CFR, “National Primary and Secondary Ambient Air Quality Standards,” Part 50, Title 40, “Protection of Environment.”
45. NRC, 2014, “Attachment 1: Staff Guidance for Greenhouse Gas and Climate Change Impacts for New Reactor Environmental Impact Statements,” COL/ESP-ISG-026. Washington, DC (ADAMS Accession No. ML14100A157).
46. NRC, RG 1.145, “Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants,” Washington, DC.
47. NRC, RG 1.111, “Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors,” Washington, DC.
48. NRC, NUREG–1437, 1996, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” Volumes 1 and 2, Washington, DC, (ADAMS Accession Nos. ML040690705 and ML040690738).
49. NRC, NUREG–1437, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” Revision 1, Washington, DC.
50. NRC, RG 4.1, “Radiological Environmental Monitoring for Nuclear Power Plants,” Washington, DC.
51. NRC, RG 4.15, “Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination)—Effluent Streams and the Environment,” Washington, DC.
52. NEI, 2007, “Industry Ground Water Protection Initiative – Final Guidance Document,” NEI 07-07, Washington, DC (ADAMS Accession No. ML091170588).
53. NRC, RG 1.112, “Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Nuclear Power Reactors,” Washington, DC.
54. Executive Order 11988, “Floodplain Management,” *Federal Register*, 42 FR 26951, May 24, 1977, Office of the President, Washington DC.
55. CFR “Determining Conformity of Federal Actions to State or Federal Implementation Plans,” Part 93, Title 40, “Protection of Environment.”
56. NRC, Memorandum from Ryan Whited to Scott Flanders, “Revision to Staff Guidance for Conducting General Conformity Determinations,” April 25, 2013, Washington, DC (ADAMS Accession No. ML12313A190).
57. NRC, NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR Edition,” Washington, DC.
58. NRC, RG 8.19, “Occupational Radiation Dose Assessment in Light-Water Reactor Power Plants -- Design Stage Man-Rem Estimates,” Washington, DC.

59. U.S. Environmental Protection Agency (EPA), “National Pollutant Discharge Elimination System: Regulations Addressing Cooling Water Intake Structures for New Facilities.” *Federal Register*, 66 FR 65256. December 18, 2011, Washington, DC.
60. Advisory Group on Non-Ionising Radiation (AGNIR), 2006, “Power Frequency Electromagnetic Fields, Melatonin and the Risk of Breast Cancer,” RCE-1, Health Protection Agency, Oxford, UK. (ADAMS Accession No. ML093210326).
61. National Institute of Environmental Health Sciences (NIEHS). 1999, “NIEHS Report on Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields,” NIH Publication No 99-4493, National Institutes of Health, Research Triangle Park, NC (ADAMS Accession No. ML093240277).
62. World Health Organization (WHO), 2007, “*Extremely Low Frequency Fields*. Environmental Health Criteria 238, Geneva, Switzerland.”³⁰
63. Soldat, J.K., N.M. Robinson, and D.A. Baker, 1974, “Models and Computer Codes for Evaluating Environmental Radiation Doses,” BNWL-1754, Battelle, Pacific Northwest Laboratories, Richland, Washington (ADAMS Accession No. ML12223A187).
64. NRC, NUREG/CR-4013, Strenge, D.L., R.A. Peloquin, and G. Whelan, 1986, “LADTAP II— Technical Reference and User Guide,” Pacific Northwest National Laboratory, Richland, WA (ADAMS Accession No. ML14098A069).
65. NRC, RG 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,” Washington, DC.
66. NRC, NUREG/CR-4653, Strenge, D.L., T.J. Bander, and J.K. Soldat, 1987, “GASPAR II— Technical Reference and User Guide,” Pacific Northwest National Laboratory, Richland, WA (ADAMS Accession No. ML14098A066).
67. CFR, “Environmental Radiation Protection Standards for Nuclear Power Operations,” Part 190, Title 40, “Protection of Environment.”
68. National Council on Radiation Protection and Measurements (NCRP), 2009, “Ionizing Radiation Exposure of the Population of the United States,” NCRP Report No. 160, Bethesda, MD.³¹
69. IAEA, 2004, “Sediment Distribution Coefficients and Concentration Factors for Biota in the Marine Environment,” Technical Report Series 422.
70. IAEA, 2010, “Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Terrestrial and Freshwater Environments,” Technical Report Series 472.

³⁰ Copies of World Health Organization (WHO) documents are available from http://www.who.int/peh-emf/research/health_risk_assess/en/index2.html.

³¹ Copies of The National Council on Radiation Protection and Measurements (NCRP) may be obtained through their Web site: <http://www.ncrponline.org/Publications/Publications.html>] or by writing to the NCRP at 7910 Woodmont Avenue, Suite 400, Bethesda, Maryland 20814-3095, Ph: 301-657-2652, fax: 301-907-8768.

71. IAEA, 1992. "Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards," Technical Report Series 332, Vienna, Austria.
72. NCRP, 1991, "Effects of Ionizing Radiation on Aquatic Organisms," NCRP Report No. 109, Bethesda, Maryland.
73. NRC, RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants," Washington, DC.
74. NRC, NUREG/CR-6613, Chanin, D. and M.L. Young, "Code Manual for MACCS2: Volume 1, User's Guide," Washington, DC (ADAMS Accession No. ML110600923).
75. NRC, "Safety Goals for the Operation of Nuclear Power Plants; Policy Statement; Correction and Republication." *Federal Register*, 51 FR 30028. August 21, 1986, Washington, DC.
76. NRC, NUREG/CR-4551, Sprung, J.L., J.A. Rollstin, J.C. Helton, H-N Jow. 1990. "Evaluation of Severe Accident Risks: Quantification of Major Input Parameters," Vol. 2, Rev. 1, Part 7, Washington, DC (ADAMS Accession No. ML12334A759).
77. NRC, NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," 1990, Washington, DC.
78. *Limerick Ecology Action vs. United States Nuclear Regulatory Commission*, U.S. Court of Appeals for the Third Circuit - 869 F.2d 719 (3d Cir. 1989).
79. NRC, NUREG/BR-0058, "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission," Washington, DC.
80. NRC, NUREG/BR-0184, "Regulatory Analysis Technical Evaluation Handbook," Washington, DC (ADAMS Accession No. ML050190193).
81. Office of Management and Budget (OMB). 2003. "Regulatory Analysis," Circular No. A-4, September 17, 2003.³²
82. NEI, 2005, "Severe Accident Mitigation Alternatives (SAMA) Analysis, Guidance Document," NEI 05-01, Revision A. Washington, DC (ADAMS Accession No. ML060530203).
83. NRC, NUREG-1437, Volume 1, Addendum 1, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants Addendum to Main Report," 1999, Washington, DC.
84. U.S. Atomic Energy Commission (AEC) 1972, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, Washington, DC (ADAMS Accession No. ML14092A626).
85. NRC, NUREG-75/038, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, Supplement 1," 1975, Washington, DC.

³² Office of Management and Budget documents are available electronically at <https://www.whitehouse.gov/omb/>.

86. Weiner, R.F., D. Hinojosa, T.J. Heames, C. Ottinger Farnum, and E.A. Kalinina, 2013, "RADTRAN 6/RadCat 6 User Guide," SAND2013-8095, Sandia National Laboratories, Albuquerque, NM (ADAMS Accession No. ML14286A092).
87. Johnson, P.E. and R.D. Michelhaugh, 2003, "Transportation Routing Analysis Geographic Information System (TRAGIS) User's Manual," ORNL/NTRC-006, Revision 0, Oak Ridge National Laboratory, Oak Ridge, TN (ADAMS Accession No. ML113260107).
88. NRC, NUREG-0586, Supplement 1, Volumes 1 and 2, "Final Generic Environmental Impact Statement of Decommissioning of Nuclear Facilities: Regarding the Decommissioning of Nuclear Power Reactors," 2002, Washington, DC.
89. Council on Environmental Quality (CEQ), 1997, "Considering Cumulative Effects under the National Environmental Policy Act."³³
90. EPA, 1999, "Consideration of Cumulative Impacts in EPA Review of NEPA Documents," EPA Publication 315-R-99-002.³⁴
91. EPA, 2012, "NEPAssist Tool."³⁵
92. NRC, "Nuclear Energy Institute; Denial of Petition for Rulemaking." *Federal Register*, 68 FR 55905. September 29, 2003, Washington, DC.
93. CEQ, "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," *Federal Register*, 46 FR 18026. March 23, 1981, Washington, DC.³⁶
94. NRC, 2005, Memorandum and Order dated December 12, 2005, regarding "In the Matter of Exelon Generation Company, LLC, (Early Site Permit for Clinton ESP Site," Commission Order CLI-05-29, Washington, DC (ADAMS Accession No. ML053460102).
95. Department of Energy/Energy Information Administration (DOE/EIA), 2011, "Electric Power Industry Terms and Definitions," Washington, DC (ADAMS Accession No. ML11294A614).
96. Hynes, John. 2009. "How to Compare Power Generation Choices." *Renewable Energy World North America* (ADAMS Accession No. ML11294A595).
97. CFR "Reactor Site Criteria," Part 100, Title 10, "Energy."
98. NRC, 1978, "Atomic Safety and Licensing Appeal Board Order In the Matter of Consumers Power Company (Midland Plant Units 1 and 2)." 7 NRC 155, ALAB-458, Washington, DC.

³³ Copies of CEQ documents are available at <http://ceq.doe.gov/>.

³⁴ Copies of EPA publications can be obtained from the EPA Library Services through their web site: http://www.epa.gov/libraries/library_services.html

³⁵ Accessible from EPA's website at: <http://www.epa.gov/oecaerth/nepa/nepassist-mapping.html>.

³⁶ Printed copies of *Federal Register* notices are available for a fee from the U.S. Government Printing Office, 732 N Capitol Street, NW Washington, DC 20401, telephone (866) 521-1800, or they may be downloaded for free from the Government Printing Office Web site: <http://www.gpo.gov/fdsys/>.

99. NRC, 1978, "Atomic Safety and Licensing Appeal Board Order In the Matter of Public Service Company of New Hampshire et al. (Seabrook Station Units 1 and 2)." 7 NRC 477, ALAB-471, Washington, DC.
100. *New England Coalition on Nuclear Pollution v. U.S. Nuclear Regulatory Commission* (NECNP v. NRC). 582 F.2d 87 (1st Circuit 1978). U.S. Court of Appeals First Circuit Decision, August 22, 1978.
101. CFR "Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material," Part 230, Title 40, "Protection of Environment."
102. NRC, "Management Directive (MD) 8.4, "Management of Facility-Specific Backfitting and Information Collection," Washington, DC.
103. NRC. NUREG-1409, "Backfitting Guidelines," July 1990, Washington, DC.

APPENDIX A

Part 50 and Part 52 Licenses and Authorizations

The information provided in Part C of this regulatory guide (RG) is for environmental reports (ERs) for combined license (COL) applications that do not reference an early site permit (ESP). This appendix provides information for the development of ERs for other authorizations and licenses that can be granted by the U.S. Nuclear Regulatory Commission (NRC) under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 (Ref. A1), and Part 52 (Ref. A2).

A.1 Early Site Permits

Before the ESP process was promulgated in 1989, the licensing process required large expenditures of time and money by applicants well before key site-specific environmental safety and emergency planning issues could be resolved. The ESP process is meant to resolve these issues well in advance of when a decision is made to build a nuclear power plant. The requirements for the information to be included in ERs for an ESP application are set forth in 10 CFR 51.45 and 51.50(b) (Ref. A3).

An ESP is a determination by the NRC as to the suitability of a site for the construction and operation of one or more nuclear reactors. It is not an authorization to construct and operate the nuclear reactor referenced in the ESP application or, in the case of a plant parameter envelope (PPE) design, a reactor that fits inside the bounding characteristics of the PPE. A PPE is a set of plant-design parameter values that an ESP applicant expects will bound the design characteristics of a reactor or reactors that might be constructed at a given site, and it serves as a surrogate for actual reactor design information. Use of this approach allows an ESP applicant to defer the decision on what reactor design to build to the COL stage. An applicant may use a PPE as a surrogate for design information to support demonstration of compliance with 10 CFR 52.17. The combination of site characteristics and PPE values will comprise the ESP bases that will be the focus for comparison in the event a COL application is submitted for the site.

Nuclear Energy Institute (NEI) publication NEI 10-01, Revision 1, “Industry Guideline for Developing a Plant Parameter Envelope in Support of an Early Site Permit” (Ref. A4), describes the development and use of an ESP application from the industry’s perspective, including development of a PPE to bound multiple reactor designs. The PPE in NEI 10-01 is an example of the parameters needed for a PPE. However, not all parameters apply to all designs and additional parameters may be needed depending on the reactor designs that the PPE is bounding.

An applicant for an ESP should review previous applications along with associated requests for additional information (RAIs) to gain an understanding of the level of detail needed to receive an ESP. For example, if a PPE is used for an ESP review, the applicant should address the assumptions for the reactor designs being evaluated and whether the designs are within the bounds of Table S-3.

All the information described in Part C of this RG will be required for an ESP application with the following exceptions:

- the ER need not include an assessment of the economic, technical, or other benefits (e.g., need for power) and costs of the proposed action
- the ER need not include an evaluation of alternative energy sources
- the ER need not include an evaluation of severe accident mitigation design alternatives (SAMDA)

However, the applicant can provide, in the ESP ER, the economic, technical, or other benefits (e.g., need for power), costs of the proposed action, an evaluation of SAMDAs and an analysis of alternative energy.

Any issues resolved by the NRC in the ESP need not be addressed in a COL application referencing the ESP unless new and significant information concerning those topics is discovered.

A.2 Combined License Referencing an Early Site Permit

A COL referencing an ESP is a combined construction permit (CP) and operating license (OL) with conditions for a nuclear power plant issued under 10 CFR Part 52, Subpart C at the site that was found suitable in the ESP and referencing either a 10 CFR Part 52 certified design or providing all the required design information for a non-certified design. ER information requirements for a COL referencing an ESP application are set forth in 10 CFR 51.45 and 51.50(c)(1).

As stated in 10 CFR 51.50(c)(1), if the COL application references an ESP, then the “Applicant’s Environmental Report—Combined License Stage” need not contain information or analyses submitted to the Commission in “Applicant’s Environmental Report—Early Site Permit Stage,” or resolved in the Commission’s ESP environmental impact statement (EIS), but must contain, in addition to the environmental information and analyses otherwise required:

- Information to demonstrate that the design of the facility falls within the site characteristics and design parameters specified in the ESP;
- Information to resolve any significant environmental issue that was not resolved in the ESP proceeding;
- Any new and significant information for issues related to the impacts of construction and operation of the facility that were resolved in the ESP proceeding;
- A description of the process used to identify new and significant information on the NRC’s conclusions in the ESP EIS. The process must use a reasonable methodology for identifying such new and significant information; and
- A demonstration that all environmental terms and conditions that have been included in the ESP will be satisfied by the date of issuance of the combined license. Any terms or conditions of the ESP that could not be met by the time of issuance of the combined license must be set forth as terms or conditions of the combined license.

All the information described in Part C, with the exception of alternative sites, should be reviewed by the applicant to determine if any new and significant information has become available since the issuance of the ESP EIS. If new and significant information has become available, the applicant must include it in the ER for the COL referencing the ESP. The applicant’s process for identifying new and significant information must be described in the ER. If SAMDAs, alternative energy sources and the economic benefits and costs were not evaluated in the ESP, then that information should be submitted in the COL application referencing the ESP. Any unresolved issues in the ESP must be addressed in the COL application.

A.3 Construction Permits and Operating Licenses

Construction Permit. A CP is an authorization from the Commission for the analysis, design, manufacture, fabrication, quality assurance, placement, erection, installation, modification, inspection or testing of a facility or activity. It is not an authorization to operate the plant. The requirements for the information to be included in the ER or ERs for a CP application are set forth in 10 CFR 51.45

and 51.50(a). All the information described in Part C of this RG should be considered for a CP application.

Operating License. An OL is an authorization from the Commission to operate a plant specified in a related CP. The requirements for the information to be included in ERs for an OL application are set forth in 10 CFR 51.45 and 51.53(b). No discussion of need for power, alternative energy sources or alternative sites for the facility is required. All the information described in Part C of this RG should be reviewed by the applicant to determine if any new information has become available for each resource area since the issuance of the CP EIS. Any new information identified will be required by the NRC staff for the review of the ER for the OL application.

A.4 Limited Work Authorizations and Site Redress

A Limited Work Authorization (LWA) is an authorization by the Commission to construct certain safety-related structures, systems, or components before issuance of a CP or COL. The requirements for the information to be included in ERs for an LWA application are set forth in 10 CFR 51.45 and 51.49(a), (b), (c), (d), (e), and (f). Requirements are provided for multiple cases including where (1) the LWA is submitted as part of a complete CP or COL application, (2) as a phased application for LWA and CP or COL, (3) as part of an ESP, and (4) following receipt of an ESP and (5) where the Commission previously prepared an EIS for construction and operation and the CP was issued and an EIS was prepared but facility construction was not completed. Only the first case (submitted as part of a complete CP or COL application) and the third case (as part of an ESP) are discussed in this appendix.

In accordance with 10 CFR 51.49(a) and (c), any ER prepared to support an LWA application must include, among other things:

- a description of the activities that would be conducted under the LWA
- a statement of the need for the activities
- a description of the environmental impacts that may be reasonably expected to result from the activities
- the mitigation measures the applicant proposes to implement to achieve the level of environmental impacts described, and a discussion of the reasons for rejecting any mitigation measures that could be employed to further reduce environmental impacts

The applicant should determine which resource areas will be affected by LWA activities and provide information on the impacts to those resource areas consistent with the information provided in Part C of this RG.

The requirements of 10 CFR 50.10(d)(3)(iii) state that the application for an LWA must also include a plan for redress of activities performed under the LWA in the case where the activities associated with the LWA are terminated by the holder of the permit or license or if the LWA is revoked by the NRC, or if the associated construction permit or combined license application is denied by the Commission. The plans for redress should be consistent with the regulations in 10 CFR 50.10(g) that the holder of the LWA must complete the redress of the site no later than 18 months after termination of construction, revocation of the LWA, or the effective date of the Commission's final decision to deny the associated CP or COL application as appropriate.

A.5 Standard Design Certification

The applicant for a standard design certification (DC), in accordance with 10 CFR 51.55, shall “submit with its application a separate document entitled “Applicant’s Environmental Report – Standard Design Certification.” The ER must “address the costs and benefits of severe accident mitigation design alternatives, and the bases for not incorporating severe accident mitigation design alternatives in the design to be certified.” The NRC staff will develop an environmental assessment (EA) based on the information provided in the ER for the DC. The requirements for the information to be included in an ER for a DC application are set forth in 10 CFR 51.55.

For additional information on SAMDAs see Chapter 5 of Part C of this RG.

A.6 COL Application Referencing Standard Design Certification

As stated in 10 CFR 51.50(c)(2), if the COL references a DC, then the combined license environmental report may incorporate by reference the EA previously prepared by the NRC for the referenced design certification. If the DC EA is referenced, then the combined license environmental report must contain information to demonstrate that the site characteristics for the COL site fall within the site parameters in the DC EA.

A.7 References

A1. *U.S. Code of Federal Regulations* (CFR), “Domestic Licensing of Production and Utilization Facilities,” Part 50, Chapter I, Title 10.

A2. CFR, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Part 52, Chapter I, Title 10 “Energy.”

A3. CFR, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” Part 51, Chapter I, Title 10 “Energy.”

A4. Nuclear Energy Institute (NEI), 2012, “Industry Guideline for Developing a Plant Parameter Envelope in Support of an Early Site Permit”. NEI 10-01, Revision 1, Washington DC, (ADAMS Accession No. ML12144A429).

APPENDIX B

Consultations

The U.S. Nuclear Regulatory Commission (NRC), as a Federal agency, is required to consult under several Federal laws with other Federal agencies. While this is the responsibility of the NRC, applicants as the proponent of the action need to provide the information that the NRC will need to complete the consultation process. Applicants should be aware of NRC's interagency consultation requirements and their environmental reports (ERs) should contain the information necessary to support the completion of the consultation process.

B.1 Endangered Species Act

Congress enacted the Endangered Species Act (ESA) in 1973 (16 U.S.C. 1531 et seq.) (Ref. B1) to protect and recover imperiled species and the habitats upon which they depend. The U.S. Fish and Wildlife Service (FWS) and the National Oceanographic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) jointly administer the ESA.

NRC licensing decisions must comply with the ESA. Section 7 of the ESA (16 U.S.C. 1536) requires that each Federal agency ensure that any action authorized, funded, or carried out by an agency is not likely to jeopardize the continued existence of any endangered or threatened species (jeopardy), or destroy or adversely modify any critical habitat for such species (adverse modification). "Action" may include licensing, rulemaking, and/or other regulatory activities. Federal agencies should act, if possible (where they have the legal authority), to prevent endangered species and their habitats from being threatened or destroyed. If an action has the potential to affect any endangered or threatened species or critical habitat, NRC must consult with the Secretary of the Interior (for freshwater and terrestrial species through the FWS) or the Secretary of Commerce (for marine and anadromous species through the NMFS). In general, the NRC consults with the FWS or NMFS (commonly referred to as "the Services") for all major Federal actions under the National Environmental Policy Act of 1969, as amended (NEPA) that require the preparation of an EIS.

The Services joint regulations implementing the ESA at 50 CFR Part 402 (Ref. B2) allow for two types of consultations: informal and formal. Informal consultation is a less structured approach than formal consultation and may include phone calls, e-mail, letters, and meetings between the NRC and the Services. Informal consultation is typically initiated early in the application review process and may be the only type of consultation needed if the Services concur with the NRC that a proposed action is "not likely to adversely affect" listed species or critical habitat. The formal consultation process is a more structured approach to meeting ESA Section 7 requirements. Formal consultation is needed if the NRC determines that a proposed action "may adversely affect" listed species or the action will result in adverse modification of designated critical habitat. Formal consultation may also be required if the Services do not concur with the NRC's conclusion that the action is "not likely to adversely affect" listed resources. Consultation is not required should the applicant and NRC conclude that the licensed action would have "no effect" on any threatened or endangered species or critical habitat; however, NRC typically chooses to seek Services concurrence on all but the most obvious "no effect" conclusions.

As a result of consultation, the Services may issue a Biological Opinion, a document that states the opinion of the Service as to whether the Federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The Biological Opinion may include an incidental take statement, reasonable and prudent measures to reduce impacts on species or habitats, and terms and conditions which the NRC must ensure that its licensee complies with

in order to be exempt from the prohibitions of Section 7(o)(2) of the ESA (50 CFR 402.14(h)-(j)). The Biological Opinion may also contain conservation recommendations which are voluntary actions that the applicant or licensee can take that benefit the species or critical habitat.

The NRC may need to prepare a Biological Assessment to support informal or formal consultation. A Biological Assessment is a document that evaluates the potential effects of the action on listed and proposed species and critical habitats potentially affected by the action, and determines whether any species or habitats are likely to be adversely affected by the action. The “Consultation Handbook” (Ref. B3) prepared by the Services, discusses the Section 7 consultation process, which includes a discussion of the information to be included in a Biological Assessment.

Note that re-initiation of consultation may also be required under certain conditions (e.g., the take of a species not authorized in a biological opinion or the listing of a new species under the ESA).

B.2 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act of 1996 (MSA) (Ref. B4) ensures that renewable fishery resources are not exhausted by overharvesting or other environmental damage. Section 305 of the MSA (16 U.S.C. 1855) requires Federal agencies to consult with the Secretary of Commerce through NMFS before authorizing any action which may adversely affect essential fish habitat (EFH) identified under MSA. The Fishery Management Councils, in conjunction with NMFS, designate EFH, which can consist of both the water column and the seafloor of an aquatic area needed to support one or more life stages of a managed fish species.

The NRC will typically initiate such EFH consultations in conjunction with its NEPA review and document the status or outcome of the EFH consultation in the EA or EIS. If no change to any aspect of aquatic resources is anticipated, then an evaluation of EFH should not be necessary.

However, if a change to any aspect of aquatic resources is anticipated, then the NRC staff should determine if the requested action will result in any adverse effects to designated EFH, and if so, contact NMFS to initiate EFH consultation. The consultation process for an environmental review requiring an EFH assessment can be found in “Essential Fish Habitat Consultation Guidance,” Version 1.1 (Ref. B5).

B.3 National Historic Preservation Act

The National Historic Preservation Act of 1966, as amended (NHPA) (Ref. B6), was promulgated to coordinate public and private efforts to preserve significant historic and cultural resources. Section 106 of the NHPA directs Federal agencies to take into account the effects of their “undertakings” on historic properties and allow the Advisory Council on Historic Preservation (ACHP) an opportunity to review and comment on the undertaking. The ACHP is an independent Federal agency charged with implementing Section 106 throughout the Federal government; NHPA Section 106 implementing regulations are at 36 CFR Part 800, “Protection of Historic Properties” (Ref. B7). “Undertakings” denotes a broad range of Federal activities, including the issuance of NRC licenses and permits. “Historic property” is any prehistoric or historic district, site, building, structure, traditional cultural property, or object included in or eligible for inclusion in the National Register of Historic Places (NRHP or National Register).

Applicants should be aware that the NRC staff will, in accordance with NHPA, consult with the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officer, and interested parties. Applicants are encouraged while developing their application to engage with the appropriate State and/or Tribal Historic Preservation Officer. Face-to-face interactions with the SHPO will generally prove beneficial as a supplement to written correspondence, especially when agency feedback is requested on

the scope and methodology for conducting cultural resource investigations. The applicant should also work with the SHPO to identify a list of potentially affected federally recognized Tribes. Based on the SHPO interactions and applicant preference, the applicant can determine if/when to initiate discussions with the potentially affected Tribes. The applicant should not view the described informal consultation activities as merely “checking a box” to meet the NRC’s expectations for an ER. Rather, such interactions will provide useful information for developing the scope of field surveys, identifying criteria for plant design or layout (e.g., impact avoidance or mitigation), and assessing resources of concern in the ER.

B.4 References

B1. Endangered Species Act of 1973, 16 U.S.C. § 1531 et seq.

B2. *U.S. Code of Federal Regulations* (CFR), “Interagency Cooperation—Endangered Species Act of 1973, as amended,” Part 402, Chapter IV, Title 50, “Wildlife and Fisheries.”

B3. U.S. Fish and Wildlife Service (FWS) and U.S. National Marine Fisheries Service (NMFS) 1998. “Consultation Handbook.”³⁷

B4. Magnuson-Stevens Fishery Conservation and Management Act of 1996, 16 U.S.C. § 1801 et seq.

B5. U.S. National Marine Fisheries Service (NMFS). 2004. “Essential Fish Habitat Consultation Guidance,” Version 1.1. National Marine Fisheries Service, Office of Habitat Conservation, Silver Spring, MD.³⁸

B6. National Historic Preservation Act of 1966, 54 U.S.C. § 300101 et seq.

B7. CFR, “Protection of Historic Properties,” Part 800, Title 36 “Parks, Forests, and Public Property.”

³⁷ Copies of National Marine Fisheries Service documents can be obtained electronically from their website: <https://www.nmfs.noaa.gov/>.

³⁸ Copies of the Essential Fish Habitat Consultation Guidance can be obtained electronically from their website: <http://www.habitat.noaa.gov/>.

APPENDIX C

Small Modular Reactor Design

The guidance in this regulatory guide (RG) was developed primarily to provide guidance for the preparation of environmental reports (ERs) for license or permit applications for large light-water reactors (LLWRs). This appendix provides additional guidance for preparation of ERs for license or permit applications for light-water small modular reactors (SMR). An SMR is a reactor unit with a nominal output of 300 MW(e) or less that is able to be factory fabricated and transported to the site for assembly of components and operation. The U.S. Nuclear Regulatory Commission (NRC) staff has identified issues for which additional information should be provided to support environmental reviews of applications addressing SMRs, (e.g., purpose and need, alternatives, cumulative impacts, the need for power, and benefit-cost). The guidance in this appendix applies to information that will be used to complete environmental reviews for SMRs associated with applications for limited work authorizations (LWAs), construction permits (CPs), operating licenses (OLs), early site permits (ESPs), and combined licenses (COL).

In general, the approach for developing an ER to support environmental reviews of SMR applications will be the same as the approach for developing an ER to support LLWR applications. However, there may be differences in the analyses based on a number of factors, including the purpose and need for the proposed action, reasonable alternatives, the need for power, benefit-cost, and the design differences between SMRs and LLWRs. The following guidance highlights areas for consideration in developing ERs for light-water SMRs.

Issues associated with environmental analyses of impacts of operation of non-light-water SMR designs, (e.g., high-temperature gas-cooled and liquid-metal reactors) are not addressed in this RG. An applicant for a non-light-water SMR should consult with the NRC staff in accordance with 10 CFR 51.40 (Ref. C1) to discuss the appropriate level of environmental studies or information which should be provided for a non-light-water reactor design (e.g., for SMRs other than light-water design, additional information about the fuel cycle, radiological effluents, and accidents should be provided).

C.1 Licensing Scenarios

There are several possible scenarios for SMR applications. The information provided in the ER would depend on the types of applications submitted and the timing of actions proposed in the application. The most likely licensing scenarios for SMR applications are described below.

C.2 Scenario 1: All Modules in One Application

A potential applicant could request licenses for multiple modules installed over time. Under this scenario, the proposed action would include licenses for all the modules that would be constructed at the proposed site. The applicant should provide a schedule as to when each module would be constructed and operated to inform the NRC staff of the timing of impacts. The information submitted to support the NRC's cumulative impact analysis should follow the guidance in Chapter 7 of this RG. In Chapter 9 of the ER, the analysis should compare the impacts of constructing and operating all of the modules at the alternative sites to the cumulative impacts of Chapter 7 of the ER to determine if an environmentally preferable or obviously superior site exists. The information submitted by the applicant to support the need-for-power analysis, alternative energy analysis and benefit-cost analysis should be based on an accounting of the full capacity of all the modules for which licenses are being requested.

C.3 Scenario 2: Two or More Separate License Applications (Subsequent application considered an expansion of the existing site)

An applicant could request licenses for one or more modules and inform the NRC that it intends to request licenses for additional modules in the future. Under this scenario, the proposed action would include only the modules for which licenses are requested. The applicant should provide sufficient information to allow the NRC to determine whether the additional modules are reasonably foreseeable for the purposes of evaluating cumulative impacts. For the additional modules to be treated as reasonably foreseeable, the siting study submitted with the original application should include consideration of all the modules.

The information requested in Chapters 4 (construction) and 5 (operations) of this RG would apply to the modules for which licenses have been requested. This would also include the construction of any infrastructure meeting the NRC's definition of "construction" in 10 CFR 51.4 that is proposed to be built with the initial units. The information requested in Chapter 7 (cumulative impacts) of this RG should include the impacts of the additional modules deemed to be reasonably foreseeable. The information requested in Chapter 9 (alternatives) of this RG for the alternative sites should also include consideration of the additional future modules that are considered reasonably foreseeable. The information requested for the need-for-power analysis in Chapter 8, alternative energy analysis in Chapter 9, and benefit-cost analysis in Chapter 10 of this RG would be based on only the modules for which licenses were being requested.

If an applicant subsequently requests licenses for additional modules, the ER for the additional modules should address all the issues except alternative sites. The ER should use the environmental impact statement (EIS) for the original group of modules as a starting point and evaluate any new and significant information relevant to environmental concerns similar to an ER for a COL referencing an ESP. The NRC staff would develop a supplemental EIS based on the information provided in the new ER.

C.4 Scenario 3: Two or More Separate License Applications (Subsequent applications not considered an expansion of the existing site)

An applicant may request a license for a certain number of modules without the siting analysis and ER considering additional modules at that site as reasonably foreseeable. The ER (and the NRC's EIS) will only consider the modules requested. If an applicant submits a subsequent application for additional modules, the ER will have to address all of the issues in this RG including alternative sites and alternative energy.

C.5 Scenario 4: ESP and COL Application

An applicant may request an ESP for all planned modules and then request COLs for only those modules it plans to build in the short term. In this scenario, the information that should be supplied in the ER for the ESP review should include consideration of all of the modules that are planned. If the proposed site is found acceptable by the NRC staff, the issue of alternative sites would be resolved for any future COLs referencing the ESP. The issues of alternative energy and need for power (if addressed in the ESP application and EIS) would also be resolved unless the NRC staff identified new and significant information on these issues in its review of the COL application referencing the ESP. Consideration of the various modules (i.e., those for which licenses are requested and those planned in the future) in the COLs would follow the same steps as described above for Scenario 2.

C.6 Summary of Licensing Scenarios

All of the scenarios described above are valid approaches. The outcome of Scenario 1 is that the NRC staff would have completed its environmental analysis for all modules, the licensing action would have been taken, and no further environmental analysis would be required.

The outcome of Scenario 2 is that, if the applicant applies for licenses for future modules, the NRC would prepare a supplemental EIS that would tier off the EIS prepared for the initial modules in which the cumulative impacts for the future modules were assessed. The supplemental EIS would evaluate any new and significant information, need for power, and the cost-benefit for the additional modules being licensed. The supplemental EIS would not evaluate alternative sites.

Under Scenario 3 the NRC would evaluate only the requested number of modules and any subsequent application for additional modules at that site would need to address all environmental review areas including alternative sites and alternative energy.

Under Scenario 4, the NRC would prepare a supplemental EIS for each COL application referencing the ESP. Key differences between Scenarios 2 and 4 are that, in Scenario 4, an applicant would be resolving siting issues in the ESP and could maintain flexibility in selecting the design until submittal of the COL application. All issues resolved in the ESP EIS would be considered resolved for the COL EIS unless the NRC staff identified new and significant information.

ESP EISs are intended to facilitate early resolution of siting issues. ESP applications can, but are not required to, include need for power or alternative energy.

C.7 Information to be provided in SMR Applications

The additional guidance below specifies differences in the information that should be provided in ERs supporting license or permit applications for SMRs.

C.7.1 Chapter 1: Introduction

In general, Chapter 1 should follow the guidance in Chapter 1 of this RG; however, the purpose and need statement may be different in the case of SMRs. For SMRs, the purpose and need is expected to include the production of electricity, although not necessarily baseload electricity, whether for a defined service area or for a specific end-user. In addition, as noted in Chapter 1 of this RG, the purpose and need statement may address additional needs other than the production of electricity. For an SMR, an additional need could be to provide the ability to install modules over longer time frames to increase capacity incrementally to follow load growth.

C.7.2 Chapter 2: Affected Environment

In general, the applicant should follow the guidance in Chapter 2 of this RG. However, because of features specific to a particular SMR design, more or less description of the affected environment may be warranted. For example:

- The hydrology section directs the applicant to characterize groundwater. The applicant should consider environmental parameters that could be affected by the installation of project structures to a greater depth below grade than current LLWR designs. The applicant should confirm that groundwater location and flow is fully characterized at all depths of the excavation.

- The ecology section directs the applicant to analyze one year of aquatic data. If the facility uses dry cooling rather than surface water or groundwater, there may be no need for one year of aquatic data because there may be no impacts to aquatic resources. However, in such case the applicant should provide sufficient justification for excluding collection and analysis of aquatic data from the ER.

C.7.3 Chapter 3: Site Layout and Plant Description

In general, the applicant should follow the guidance in Chapter 3 of this RG. However, the applicant should also describe the unique features of an SMR facility, including a plot plan that shows the location of proposed modules and the locations of environmental interfaces. The site layout and plant description should clearly describe the scope of the project as proposed in the license application, including the total number of modules requested to be licensed and the proposed operational date for each module. The applicant should also include any information known about planned installation of future units.

C.7.4 Chapter 4: Construction Impacts at the Proposed Site

In general, the applicant should follow the guidance in Chapter 4 of this RG for preparing a discussion of construction impacts. However, because modules may be installed over time to meet the demand for electricity, the applicant should describe and evaluate construction impacts over the time frame specified in the application.

As part of the proposed action, the applicant may install infrastructure and facilities that could be used to support additional reactor modules. These activities should be evaluated as part of the construction impact analysis in the ER.

C.7.5 Chapter 5: Operational Impacts at the Proposed Site

In general, the applicant should follow the guidance in Chapter 5 of this RG for preparing a discussion of the operational impacts. However, because modules may be installed over time to meet the demand for electricity, the applicant should evaluate operational impacts over the time frame specified in the application.

Specific SMR designs may have features that differ from LLWR designs. For example, dry cooling may be proposed, resulting in significantly less consumptive water use. In these cases, an applicant would not need to evaluate impacts from entrainment or impingement, or impacts from thermal discharges to a waterbody. The ER should include a short statement that environmental impacts in these areas are not expected because of the design features of the proposed plant.

C.7.6 Chapter 6: Fuel Cycle, Transportation, and Decommissioning

The applicant should follow the guidance in Chapter 6 of this RG for preparing a discussion of the fuel cycle, transportation, and decommissioning.

C.7.7 Chapter 7: Cumulative Impacts

In general, the applicant should follow the guidance in Chapter 7 of this RG for preparing a discussion of the cumulative impacts. The applicant should consider impacts from the total number of modules being proposed in the licensing action, in addition to impacts from other reasonably foreseeable past, present, and future actions.

Under licensing Scenarios 1 and 3 described in Section C.1, the impacts of all the modules for which licenses have been requested would be direct impacts and cumulative impacts for all modules should be addressed in the ER. Under Scenario 2, the ER should address cumulative impacts for those modules for which licenses have been requested plus future modules that the applicant considers reasonably foreseeable. Under Scenario 4, the additional modules considered in the ER and EIS for the ESP should be considered reasonably foreseeable future actions for the evaluation of cumulative impacts of the modules considered in the initial COL applications.

C.7.8 Chapter 8: Need for Power

In general, the applicant should follow the guidance in Chapter 8 of this RG for preparing a discussion of the need for power. For all licensing scenarios described in Section C.2, the analysis of the need for power and the cost-benefit analysis in Chapter 10 of this RG/the ER should only consider the modules for which licenses are being requested.

C.7.9 Chapter 9: Environmental Impacts of Alternatives

In general, the applicant should follow the guidance in Chapter 9 of this RG for the development of a discussion of the project alternatives.

With LLWRs, reasonable alternatives to the proposed action may be limited because of the plant's large installed capacity. Because SMRs are much smaller in generating capacity, installations of individual renewable energy technologies (or combinations of renewable and non-renewable energy technologies), conservation, and/or energy efficiency could potentially meet the project's purpose and need. An alternative is not reasonable if it does not meet the purpose and need statement. The applicant should identify alternative energy sources that would meet the purpose and need of the proposed action as defined in Chapter 1 of the ER. For example, the alternative power source would generate the same amount of electrical energy (i.e., MWh/yr) with the same reliability as that generated by the total number of SMR modules for which the applicant has requested licenses, as well as any additional purposes identified in the purpose and need statement in Chapter 1.

For the site-selection process, the applicant should consider sites that could support all the modules for which licenses or permits are being requested, plus any planned future modules that the applicant concludes are reasonably foreseeable. Because SMRs are expected to require a smaller site footprint than LLWRs, a larger set of potential sites may need to be included in the site-selection process.

An applicant may request construction at a specific location to meet their purpose and need for an SMR facility. For example, an applicant may propose to use excess heat for industrial processes or station heating as an additional purpose for the proposed project, or provide a secure energy source for military, government, or critical industrial facilities. In these cases, the applicant must still submit alternative sites. However, the ROI used for the site-selection process may be much smaller than is typical for LLWRs.

C.7.10 Chapter 10: Conclusion and Recommendation

Chapter 10 of this RG should provide sufficient guidance for preparing concluding remarks and discussing the project's benefits and the environmental costs for the proposed action for which a license or permit is being requested. However, the applicant should note that any additional purposes and needs that are unique to the proposed SMR project should be accompanied by a description (quantified or qualified as the subject permits) of the benefits of each additional purpose in sufficient detail so that a fully informed benefit-cost conclusion can be reached.

C.8 Reference

C1. *U.S. Code of Federal Regulations* (CFR), “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” Part 51, Chapter I, Title 10 “Energy.”³⁹

³⁹ The *Code of Federal Regulations* may be obtained electronically from the U.S. Government Printing Office at: <http://www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR>