



# DRAFT REGULATORY GUIDE

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## DRAFT REGULATORY GUIDE DG-4021

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# GENERAL SITE SUITABILITY CRITERIA FOR NUCLEAR POWER STATIONS

## A. INTRODUCTION

This guide describes a method that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable to implement the site suitability requirements for nuclear power stations.

The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.), as amended, and the Energy Reorganization Act of 1974 assign the NRC the responsibility for the licensing and regulation of private nuclear facilities to protect public health and safety. Title 10 of the *Code of Federal Regulations*, Part 100, "Reactor Site Criteria" (10 CFR Part 100) (Ref. 1), requires that the NRC consider population density; use of the site environs, including proximity to manmade hazards; and the physical characteristics of the site, including seismology, meteorology, geology, and hydrology, in determining the acceptability of a site for a nuclear power reactor. Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," to 10 CFR Part 100 and 10 CFR 100.23, "Geologic and Seismic Siting Criteria," provide seismic and geologic siting criteria for nuclear power plants. Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities" (Ref. 2), establishes minimum requirements for the principal design criteria for water-cooled nuclear power plants, and Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50 provides engineering criteria for nuclear power plants. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants" (Ref. 3), presents the requirements and criteria for the technical contents of applications for the issuance of early site permits, standard design certifications, combined licenses, standard design approvals, and manufacturing licenses for nuclear power plants. Some of these criteria are directly related to site characteristics, as well as to events and conditions outside the nuclear power unit.

The National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.), as amended, implemented by Executive Orders 11514 and 11991 and the Council on Environmental Quality's regulations (40 CFR Parts 1500–1508 (Ref. 4)), requires that all agencies of the Federal Government prepare detailed environmental statements on proposed major Federal actions that will significantly affect

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This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received final staff review or approval and does not represent an official NRC final staff position. Public comments are being solicited on this draft guide (including any implementation schedule) and its associated regulatory analysis or value/impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Rules, Announcements, and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; submitted through the NRC's interactive rulemaking Web page at <http://www.nrc.gov>; or faxed to (301) 492-3446. Copies of comments received may be examined at the NRC's Public Document Room, 11555 Rockville Pike, Rockville, MD. Comments will be most helpful if received by February 25, 2011.

Electronic copies of this draft regulatory guide are available through the NRC's interactive rulemaking Web page (see above); the NRC's public Web site under Draft Regulatory Guides in the Regulatory Guides document collection of the NRC Library at <http://www.nrc.gov/reading-rm/doc-collections/>; and the NRC's Agencywide Documents Access and Management System (ADAMS) at <http://www.nrc.gov/reading-rm/adams.html>, under Accession No. ML102380302. The regulatory analysis may be found in ADAMS under Accession No. ML102380311.

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the quality of the human environment. A principal objective of NEPA is to require the Federal agency to consider, in its decision making process, the environmental impacts of each proposed major action and the available alternative actions, including alternative sites.

In 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions” (Ref. 5), the NRC sets forth regulations applicable to its preparation and processing of environmental impact statements and related documents pursuant to Section 102(2)(C) of NEPA.

The limitations on the Commission’s authority and responsibility pursuant to NEPA imposed by the Clean Water Act (Federal Water Pollution Control Act (FWPCA)) (33 U.S.C. 1251 et seq.), as amended, are specified in 10 CFR 51.10(c). In 10 CFR 51.45, the NRC sets forth the contents that an applicant must include in its environmental report.

This guide 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. Applicants may use the guidelines in identifying suitable candidate sites for nuclear power stations. The decision that a station may be built on a specific candidate site is based on a detailed evaluation of the proposed site-plant combination and a cost-benefit analysis comparing it with alternative site-plant combinations, as discussed in Regulatory Guide 4.2, “Preparation of Environmental Reports for Nuclear Power Stations”<sup>1</sup> (Ref. 6).

Chapter 9 of both Regulatory Guide 4.2 and NUREG-1555, “Standard Review Plans for Environmental Reviews for Nuclear Power Plants,” (Ref. 7) discusses the selection of a site from among alternative sites; the applicant should present its site-plant selection process as the consequence of an analysis of alternatives for which environmental costs and benefits were evaluated and compared and then weighed against those of the proposed facility.

This guide is intended to assist applicants in the initial stage of selecting potential sites for a nuclear power station. Each site that appears to be compatible with the general criteria discussed in this guide should be examined in greater detail before it can be considered a “candidate” site (i.e., one of the group of sites to be considered in selecting a “proposed” or “preferred” site).<sup>2</sup>

This guide should be used only in the initial stage of site selection because it does not provide detailed guidance on the various relevant factors and format for ranking the relative suitability or desirability of possible sites. This guide provides a general set of safety and environmental criteria that the NRC staff has found to be valuable in assessing candidate site identification in specific licensing cases.

The information needed to evaluate potential sites at this initial stage of site selection is assumed to be limited to information that is obtainable from published reports, public records, public and private agencies, and individuals knowledgeable about the locality of a potential site. Although in some cases the applicants may have conducted on-the-spot investigations, it is assumed here that these investigations would be limited to reconnaissance-type surveys at this stage in the site selection process.

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<sup>1</sup> For the purpose of this guide, nuclear power station refers to the nuclear reactor unit or units, nuclear steam supply, electric generating units, auxiliary systems including the cooling system and structures such as docks that are located on a given site, and any new electrical transmission towers and lines erected in connection with the facilities.

<sup>2</sup> See Chapter 9 of Regulatory Guide 4.2 for a discussion of site selection procedures. The “proposed” site submitted by an applicant for a construction permit is that site chosen from a number of “candidate” sites the applicant prefers and on which the applicant proposes to construct a nuclear power station.

The safety issues discussed include geologic/seismic, hydrologic, and meteorologic characteristics of proposed sites; exclusion area and low-population zone; population considerations as they relate to protecting the general public from the potential hazards of serious accidents; potential effects on a station from accidents associated with nearby industrial, transportation, and military facilities; emergency planning; and security plans. The environmental issues discussed concern potential impacts from the construction and operation of nuclear power stations on ecological systems, water use, land use, the atmosphere, aesthetics, socioeconomics, and environmental justice.

This guide does not discuss details of the engineering designs required to ensure the compatibility of the nuclear station and the site or the detailed information required for the preparation of the safety analysis and environmental reports. Nor does the guide address nuclear power reactor site suitability as it may be affected by the Commission's requirements for materials safeguards and site security for nuclear power plants.

Selecting a suitable site for a nuclear power station may require a significant commitment of time and resources, including safety and environmental considerations. Site selection involves consideration of public health and safety, engineering and design, economics, institutional requirements, environmental impacts, and other factors. The potential impacts of the construction and operation of nuclear power stations on the physical and biological environment and on social, cultural, and economic features<sup>3</sup> (including environmental justice) are usually similar to the potential impacts of any major industrial facility, but nuclear power stations are unique in the degree to which potential impacts of the environment on their safety must be considered. The safety requirements are primary determinants of the suitability of a site for nuclear power stations, but environmental impacts are also important and need to be evaluated.

In the site selection process, coordination between applicants for nuclear power stations and various Federal, State, local, and Native American tribal agencies will be useful in identifying potential problem areas.

Appendices A and B to this guide summarize the important safety-related and environmental considerations for assessing the site suitability of nuclear power stations.

With regard to international standards, the International Atomic Energy Agency (IAEA) has established a series of safety standards for protecting people and the environment. Safety Guides present international good practices to help users striving to achieve high levels of safety. Similar to this regulatory guide, IAEA Safety Guide NS-R-3, "Site Evaluation for Nuclear Installations" (Ref. 8), addresses recommendations for the collection of information to assess the safety and environmental suitability of a site for nuclear installation. The NRC has an interest in facilitating the harmonization of standards used domestically and internationally. Use of this regulatory guide would generally be consistent with the principles and basic safety aspects described in the IAEA safety guide on site evaluation.

The NRC issues regulatory guides and standard review plans 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.

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<sup>3</sup> Biological and physical environment includes geology, geomorphology, surface and ground water hydrology, climatology, air quality, limnology, water quality, fisheries, wildlife, and vegetation. Social and cultural features include scenic resources, recreation resources, archeological and historical resources, and community resources, including land use patterns.

This regulatory guide contains information collection requirements covered by 10 CFR Part 50, which the Office of Management and Budget (OMB) approved under OMB control number 3150-0011. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request unless the requesting document displays a currently valid OMB control number. This regulatory guide is a rule as designated in the Congressional Review Act (5 U.S.C. 801–808). However, OMB has not found it to be a major rule as designated by the Congressional Review Act.

## B. DISCUSSION

### **Geology and Seismology**

Nuclear power stations must be designed to prevent the loss of safety-related functions. Generally, the most restrictive safety-related site characteristics considered in determining the suitability of a site are surface faulting, potential ground motion and foundation conditions<sup>4</sup> (including liquefaction, subsidence, and landslide potential), and seismically induced floods. Criteria that describe the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability are in 10 CFR 100.23 (59 FR 52255) and 10 CFR 52.17(a)(1)(vi). Safety-related site characteristics are identified in Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants, LWR Edition” (Ref. 10); Regulatory Guide 1.208, “A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion” (Ref. 11); and Regulatory Guide 1.59, “Design Basis Floods for Nuclear Power Plants” (Ref. 12). Regulatory Guide 1.132, “Site Investigations for Foundations of Nuclear Power Plants” (Ref. 13), Regulatory Guide 1.138, “Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants” (Ref. 14), and Regulatory Guide 1.198, “Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites” (Ref. 15), provide guidance to determine the suitability of the site foundations for the nuclear plant station. In addition to geologic and seismic evaluation for assessing seismically induced flooding potential, Regulatory Guide 1.206 and Regulatory Guide 1.59 describe hydrologic criteria, including coincident flood events that should be considered.

### **Atmospheric Extremes and Dispersion**

The potential effect of natural atmospheric extremes (e.g., tornadoes<sup>5</sup> and exceptional icing conditions<sup>6</sup>), regional climatology, and local meteorology<sup>7</sup> on the safety-related structures of a nuclear station should be considered. NUREG-0800, Section 2.3.1, discusses review procedures for examination of the long-term weather cycles, such as 100-year return periods for extreme weather conditions such as winter precipitation, maximum windspeed, and temperatures that define a site’s meteorological characteristics. A 30-year weather record should be considered in an evaluation of the water requirements for the ultimate heat sink. More data and studies on longer term weather cycles should be examined because of concerns about the potential impact of climate change as it relates to nuclear safety and the environment. However, the atmospheric extremes that may occur at a site are not normally critical in determining the suitability of a site because safety-related structures, systems, and components (SSCs) can be designed to withstand most atmospheric extremes with associated site-specific costs.

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<sup>4</sup> See NUREG-0800, “Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” Section 2.5.1, “Basic Geologic and Seismic Information” (Ref. 8), and Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants (LWR Edition)” (Ref. 9).

<sup>5</sup> See Regulatory Guide 1.76, “Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants” (Ref. 16).

<sup>6</sup> See Ref. 10.

<sup>7</sup> See NUREG-0800, Sections 2.3.1 and 2.3.2.

The atmospheric characteristics at a site are an important consideration in evaluating the dispersion of radioactive effluents from both postulated accidents and routine releases in gaseous effluents.<sup>8</sup> In addition to meeting the NRC requirements for the dispersion of airborne radioactive material, the station must meet State and Federal requirements of the Clean Air Act (42 U.S.C. 7401 et seq.), as amended. This is unlikely to be an important consideration for nuclear power station siting unless (1) a site is in an area where existing air quality is near or exceeds standards, (2) there is a potential for interaction of the cooling system plume with a plume containing noxious or toxic substances from a nearby facility, or (3) the auxiliary generators are expected to operate routinely.

Regulatory Guide 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants" (Ref. 18), describes atmospheric data that the staff considers acceptable for the required assessment of the potential dispersion of radioactive material. NUREG-0800, Section 2.3.3, "Onsite Meteorological Measurements Programs," describes the staff's review procedures.

In the evaluation of potential sites, onsite meteorological monitoring can determine if the atmospheric conditions at a site are adequately represented by the available atmospheric data for the area. Canyons or deep valleys frequently have atmospheric variables that are substantially different from those variables measured for the general region. Other topographical features such as hills, mountain ranges, and lake or ocean shorelines can affect the local atmospheric conditions at a site and can cause the dispersion characteristics at the site to be less favorable than those in the general area or region. More stringent design or effluent objectives might be required in such cases.

While it is the concentration of radioactive materials in the atmosphere at any distance from the point of release,  $\chi$  (curies per cubic meter (Ci/m<sup>3</sup>)), that must be controlled, the ratio  $\chi/Q$ , where  $Q$  (curies per second) (Ci/s) is the rate of release of radioactive materials from the source, has become a commonly evaluated term because it depends only on atmospheric variables, distance from the source, and whether airborne releases occur from a single plant stack or via multiple building vents or plant stacks.

If the dispersion of radioactive material released following a design-basis accident is insufficient at the boundary of the exclusion area (see the following section, "Exclusion Area and Low-Population Zone") or the outer boundary of the low-population zone, the plant design would not satisfy the requirements in 10 CFR 50.34(a)(1). In this case, the design of the station would be required to include appropriate and adequate compensating engineered safety features. In addition, meteorological conditions are to be determined (1) for use in the environmental report required by 10 CFR Part 51 and (2) for verification of the criteria specified in the design control document for a certified plant design.

Local fogging and icing can result from water vapor discharged into the atmosphere from cooling towers, lakes, canals, or spray ponds, but can generally be acceptably mitigated by station design and operational practices. However, some sites have the potential for severe fogging or icing because of local

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<sup>8</sup> Radiation doses associated with routine releases and anticipated operational occurrences of airborne radioactive materials must be kept "as low as is reasonably achievable" (ALARA) (see 10 CFR 20.1101(b), (Ref. 17) and must comply with effluent concentration limits of Appendix B to 10 CFR Part 20 and dose limits for members of the public under 10 CFR 20.1301 and 20.1302. In addition, 10 CFR 20.1301(e) requires compliance with the EPA's generally applicable environmental radiation standards of 40 CFR Part 190. The requirements for design objectives for equipment to control releases of radioactive material in effluents from nuclear power reactors are set forth in 10 CFR 50.34a. Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50 provides guidance on the requirements for design objectives and technical specification for limiting conditions for operation for light-water-cooled nuclear power plants. Further, 10 CFR 50.36a(a) provides that, to keep power reactor effluent releases ALARA, each license authorizing operation of such a facility will include technical specifications regarding the establishment of effluent control equipment and reporting of actual releases.

atmospheric conditions. For example, areas of unusually high moisture content that are protected from large-scale airflow patterns are most likely to experience these conditions. The impacts are generally of greatest potential importance relative to transportation or electrical transmission systems in the vicinity of a site. NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants," Section 5.1.1, "The Site and Vicinity" (Ref. 7), provides staff guidance for the evaluation of fogging and icing induced by a nuclear power plant, while Section 5.3.3.1, "Heat Dissipation to the Atmosphere," discusses the physical and aesthetic impacts of cloud formation, cloud shadowing, additional precipitation, and increased ground-level humidity.

A cooling system designed with special consideration for reducing drift might be needed because of the sensitivity of the natural vegetation or the crops in the vicinity of the site to damage from airborne salt particles. The vulnerability of existing industries or other facilities in the vicinity of the site to corrosion by drift from cooling tower or spray system drift should be considered. Not only are the amount, direction, and distance of the drift from the cooling system important, but the salt concentration above the natural background salt deposition at the site is also important in assessing drift effects. None of these considerations is critical in evaluating the suitability of a site, but they could result in special cooling system design requirements or in the need for a larger site to confine the effects of drift within the site boundary. The environmental effects of salt drift are most severe where saline water or water with high mineral content is used for condenser cooling.

Cooling towers produce cloudlike plumes that vary in size and altitude depending on the atmospheric conditions. The plumes often extend a few miles in length before dissipating, but the plumes themselves or their shadows could have aesthetic impacts. Visible plumes emitted from cooling towers in the vicinity of airports could cause a hazard to aviation.

### **Exclusion Area and Low-Population Zone**

A reactor licensee is required by 10 CFR 100.21(a) to designate an exclusion area and to have authority to determine all activities within that area, including removal of personnel and property. In selecting a site for a nuclear power station, it is necessary to provide for an exclusion area in which the applicant has such authority. Transportation corridors such as highways, railroads, and waterways are permitted to traverse the exclusion area provided (1) these are not so close to the facility as to interfere with normal operation of the facility and (2) in case of emergency, appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway in order to protect public health and safety.

10 CFR 50.34(a)(1)(ii)(D)(1) requires the exclusion area to be of such a size that an individual assumed to be located at any point on its boundary would not receive a radiation dose in excess of 25 rem total effective dose equivalent (TEDE) over any 2-hour period following a postulated fission product release into the containment. The required exclusion area size involves consideration of the atmospheric characteristics of the site as well as plant design.

A reactor licensee is also required by 10 CFR 100.21(a) to designate an area immediately surrounding the exclusion area as a low-population zone (LPZ). The size of the LPZ must be such that the distance to the boundary of the nearest densely populated center containing more than about 25,000 residents must be at least one-and-one-third times the distance from the reactor to the outer boundary of the LPZ. The boundary of the population center should be determined by considering population distribution, not political boundaries.

10 CFR 50.34(a)(1)(ii)(D)(2) requires the LPZ to be of such a size that an individual located on its outer boundary during the course of the postulated accident (assumed to be 30 days) would not receive a radiation dose in excess of 25 rem TEDE. The size of the LPZ depends on atmospheric dispersion characteristics and population characteristics of the site, as well as aspects of plant design.

10 CFR 50.47, "Emergency Plans," provides requirements for emergency preparedness provisions for an early site permit and includes emergency planning provisions for authorizations of only fuel loading or low-power testing and training (up to 5 percent of the rated power). Specific technical provisions for emergency plans for a proposed site are in 10 CFR 52.17, "Contents of Applications; Technical Information," and 10 CFR 52.79, "Contents of Applications; Technical Information in Final Safety Analysis Report," requires an applicant's final safety analysis report to include information related to site location, the facility location on the site, population considerations, locations of nearby facilities, postulated releases in the event of an accident, and other technical requirements. NUREG-0800, Sections 2.1.1 and 2.1.2, and Regulatory Guide 1.206 provide additional guidance regarding NRC staff reviews of site location and description and exclusion area authority and control.

## **Population Considerations**

As stated in 10 CFR 100.21(h), reactors should be located away from very densely populated centers; areas of low population density are generally preferred. In addition, 10 CFR 100.21(h) states that, in determining the acceptability of a particular site located away from a very densely populated center but not in an area of low density, consideration will be given to safety, environmental, economic, or other factors that may result in the site being found acceptable. Population data should be estimated in relation to the time of initial plant approval, rather than initial site approval, as recommended by Regulatory Guide 1.206. Also, Regulatory Guide 1.206 contains guidance regarding predicting population for periods beyond the start of power plant operations and notes that population projections may be made by decade for a 40-year period beyond the latest date that the early site permit unit could start operation. Section 2.1.3 of Review Standard RS-002, "Process Applications for Early Site Permits," issued May 2004 (Ref. 19), discusses methodologies for projecting populations over the lifetime of the facility.

Locating reactors away from densely populated centers is part of the NRC's defense-in-depth philosophy and facilitates emergency planning and preparedness, as well as reduces potential doses and property damage in the event of a severe accident. The numerical values given in this guide (see Regulatory Position 4, "Population Considerations") are generally consistent with past NRC practice and reflect consideration of severe accidents, as well as the demographic and geographic conditions of the United States.

## **Emergency Planning**

According to 10 CFR 100.21(g), "Physical characteristics unique to the proposed site that could pose significant impediment to the development of emergency plans must be identified."

Additionally, 10 CFR 50.47(a)(1) requires a reasonable assurance finding that adequate protective measures can and will be taken in the event of a radiological emergency before the NRC can issue an operating license for a nuclear power plant. 10 CFR 50.47(d) allows issuance of an operating license authorizing only fuel loading or low-power testing and training (up to 5 percent of the rated power) without certain NRC or Federal Emergency Management Agency reviews, findings, or determinations concerning the state of offsite emergency preparedness. As authorized in 10 CFR 52.17(b)(2)(ii), a proposed site that is contiguous with an existing nuclear power plant site should consider the complete and integrated emergency plans that would be necessary for construction and operation of one or more

reactors at the proposed site (see also the U.S. Department of Energy's "Report on Lessons Learned from the NP 2010 Early Site Permit Program," dated March 26, 2008 (Ref. 20)). For green-field siting of nuclear power plants, emergency plans for one or more reactors should be considered (see Supplement 2 to NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Plans and Preparedness in Support of Nuclear Power Plants: Criteria for Emergency Planning in an Early Site Permit Application" (Ref. 21), and guidance in Section 13.3 of RS-002 (Ref. 19).

Adequate plans must be developed for two areas, or emergency planning zones (EPZs): the plume exposure pathway EPZ and ingestion pathway EPZ. As stated in 10 CFR 50.47, the plume exposure pathway EPZ for nuclear power plants generally consists of an area about 16 kilometers (km) (10 miles (mi)) in radius, and the ingestion pathway EPZ generally consists of an area about 80 km (50 mi) in radius. The exact size and configuration of the EPZs should be determined in relation to local emergency response needs and capabilities, as they are affected by such conditions as demography, topography, land characteristics, access routes, and jurisdictional boundaries.

## **Security**

10 CFR 52.17(a)(1)(x) requires an Early Site Permit (ESP) applicant's site safety analysis report to include "information demonstrating that site characteristics are such that adequate security plans and measures can be developed."

10 CFR 100.21(f) states: "Site characteristics must be such that adequate security plans and measures can be developed."

NUREG-0800, Section 13.6.3, "Physical Security – Early Site Permit Review Responsibilities," addresses in part: the location of transportation routes (e.g., rail, water, and roads), pipelines, airports, hazardous material facilities, and pertinent environmental features that should be considered for the implementation of security plans and for potential adverse impacts for response activities related to security operations.

The applicant should perform an analysis of site characteristics and hazards to determine and identify if adequate security plans and measures can be developed to prevent radiological sabotage. Therefore, the characteristics and hazards of natural, existing, or proposed man-made features at or located in proximity to a proposed site should not preclude development of adequate security plans, and will not adversely affect the proposed site's security operations with regard to meeting NRC requirements.

## **Hydrology**

### *Flooding*

10 CFR 100.23 requires the size of the seismically induced floods and water waves that could affect a site from either locally or distantly generated seismic activity to be determined. Regulatory Guide 1.59 describes an acceptable method for determining the design-basis floods for sites along streams or rivers and discusses the phenomena producing comparable design-basis floods for coastal, estuary, and Great Lakes sites. The design-basis flood determinations include the effects of sea water rise and temperature increases caused by global warming effects and climate change. The effects on station safety functions of a probable maximum flood (as defined in Regulatory Guide 1.59), seiche, surge, or seismically induced flood (such as might be caused by dam failures or tsunamis) can generally be controlled by engineering design or protection of the safety-related SSCs identified in Regulatory Guide 1.29, "Seismic Design Classification" (Ref. 23). Regulatory Guide 1.206 and NUREG-0800,

Sections 2.4.1 to 2.4.4, provide additional guidance on determining design-basis flooding and flood mechanisms at power reactor sites. Additional information can be obtained from American National Standards Institute/American Nuclear Society (ANSI/ANS) 2.8, “Determining Design Basis Flooding at Power Reactor Sites” (Ref. 24); DOE-STD-1020-2002, “Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities” (Ref. 25); DOE-STD-1021-93, “Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components” (Ref. 26); DOE STD-1021-94, “Natural Phenomena Hazards Characterization Criteria” (Ref. 27); and DOE-STD-1023-95, “Natural Hazards Phenomena Hazards Assessment Criteria” (Ref. 28). For some river valleys, flood plains, or areas along coastlines, sufficient information might not be available for the evaluations needed to satisfy the criteria for seismically induced flooding. In such cases, study of the potential for dam failure, river blockage, or diversion in the river system or distantly and locally generated sea waves might be needed to determine the suitability of a site. In lieu of detailed investigations, Regulatory Guide 1.59 and Regulatory Guide 1.206 present acceptable analytical techniques for evaluating seismically induced flooding.

### *Water Availability*

Nuclear power stations require reliable sources of water for steam condensation, service water, the emergency core cooling system, and other functions. Where water is in short supply, the recirculation of the hot cooling water through cooling towers, artificial ponds, or impoundments has been practiced.

Nuclear power plants require that there be sufficient water available for cooling during plant operation and normal shutdown, for the ultimate heat sink, and for fire protection. A highly dependable system of water supply sources should be shown to be available for postulated occurrences of natural and site-related accident phenomena as discussed in Regulatory Guide 1.59. NUREG-0800, Section 2.4.1, notes that sources of hydrometeorological and streamflow data for determination of an adequate water supply for safety-related SSCs should be identified. NUREG-0800, Section 2.4.4, discusses staff reviews of potential loss of water supply due to dam failures and the effect of this loss on safety-related SSCs.

The limitations imposed by existing laws or allocation policies govern the use and consumption of cooling water at potential sites for normal operation. Regulatory Guide 1.27, “Ultimate Heat Sink for Nuclear Power Plants” (Ref. 29), provides guidance on water supply for the ultimate heat sink and discusses the safety requirements. Consumption of water may necessitate an evaluation of existing and future water uses in the area to ensure adequate water supply during droughts for both station operation and other water users (i.e., nuclear power station requirements versus public water supply). NUREG - 1555 contains the guidance to staff for evaluating the environmental impacts of consumptive water use. Regulatory agencies should be consulted to avoid potential conflicts.

To evaluate the suitability of sites, there should be reasonable assurance that the applicant can obtain permits for consumptive use of water in the quantities needed for power plant operation for the approximate capacity and type of cooling from the appropriate State, local, or regional agency, in accordance with the agency’s programs and policies. Where required by law, demonstration of a request for certification of the rights to withdraw or consume water and an indication that the request is consistent with appropriate State, local, and regional programs and policies are to be provided as part of the application for a construction permit or operating license.

The availability of essential water during periods of low flow or low-water level is an important initial consideration for identifying potential sites on rivers, small shallow lakes, or along coastlines. Both the frequency and duration of periods of low flow or low water level should be determined from the historical record and, if the cooling water is to be drawn from impoundments, from projected operating practices.

Streamflow records might not cover a sufficiently long period to encompass major droughts or the probable minimum flow for the region. Statistical techniques may be used to extend and complement the period of record to help identify the expected minimum low flow for the region. The U.S. Geological Survey hydrologically based 7Q10 low-flow condition from regional streamflow historical records can be used for screening-level analysis. This statistical method is based on selecting and identifying an extreme value as the lowest 7-day average flow in a 10-year period. There is a 65-percent chance that a 7Q10 minimum flow will occur in any 10-year period. If the 7Q10 is too low to supply adequate water for the plant, then other sources of water for nonsafety-related and safety-related structures and ultimate heat sink requirements would need to be identified. See References 30 and 31 for hydrologic frequency analysis applied to regional stream gauges with sufficient record lengths to represent expected minimum flows.

### *Water Quality*

Thermal and chemical effluents discharged to navigable streams are governed by the FWPCA (also known as the Clean Water Act), as amended; 40 CFR Part 122, “EPA Administered Permit Programs: The National Pollutant Discharge Elimination System” (Ref. 32); 40 CFR Part 423, “Steam Electric Power Generating Point Source Category” (Ref. 33); and State water quality standards. The applicant should also determine whether there are other relevant regulations current at the time sites are under consideration. Section 401(a)(1) of the FWPCA requires, in part, that any applicant for an NRC construction permit, early site permit, or combined license for a nuclear power station provide to the NRC certification from the State that any discharge will comply with applicable effluent limitations and other water pollution control requirements. In the absence of such certification, the NRC cannot issue a construction permit, early site permit, or combined license, unless the requirement is waived by the State or the State fails to act within a reasonable period of time. A National Pollution Discharge Elimination System (NPDES) permit to discharge effluents to navigable streams pursuant to Section 402 of the FWPCA may be required for a nuclear power station to operate in compliance with the Act, but it is not a prerequisite to an NRC construction permit, operating license, or combined license.

The suitability of sites for a specific plant design in areas with a complex ground water hydrology, or of sites located over aquifers that are or may be used by large populations for domestic or industrial water supplies or for irrigation water, can be determined only after the potential impacts of the reactor on the ground water have been reliably assessed. Site environmental parameters, which include hydrological and meteorological characteristics, should be comparable to those used in the plant probabilistic risk assessment and environmental analysis.

Although management of the quality of surface waters is important, water quality is not generally a determining factor in assessing the suitability of a site since adequate design alternatives can be developed to meet FWPCA requirements and the Commission’s regulations implementing NEPA. The following are examples of potential environmental effects of station construction and operation that should be assessed: physical and chemical environmental alterations in habitats of important species, including plant-induced rapid changes in environmental conditions; changes in normal current direction or velocity of the cooling water source and receiving water; scouring and siltation resulting from construction and cooling water intake and discharge; alterations resulting from dredging and spoil disposal; and interference with shoreline processes.

### *Radionuclide Retention and Transport*

Aquifers that are or may be used by large populations for domestic, municipal, industrial, or irrigation water supplies provide potential pathways for the transport of radioactive material to man in the event of an accident. To evaluate the suitability of proposed sites located over such aquifers, detailed studies of factors identified in Section 2.4.13 of Regulatory Guide 1.206 and SRP Section 11.2 and

Branch Technical Position (BTP) 11-6 (Ref. 9) should be reviewed and considered in the evaluation. The potential adverse effects of choosing sites within areas that the U.S. Environmental Protection Agency (EPA) has designated as sole source aquifers (SSAs), or that have the potential of being designated as an SSA in the future, should be considered.

To be able to assess radionuclide retention and transport via ground water, the following information should be determined for the site:

- a soil, sediment, and rock characteristics (e.g., grain size, hydraulic conductivity, fracturing),
- b source of radioactivity, radionuclide and radioactivity inventories, and assumed release mechanism from the nuclear island, taking into account plant design features,
- c adsorption and retardation coefficients for radioactive materials,
- d ground water velocity if ground water is impacted,
- e dispersion and dilution processes in surface water bodies if surface water is impacted,
- f distance to the nearest offsite point of entry in a surface water body or ground water resources, and
- g environmental transport mechanisms and exposure pathways leading to direct uses (e.g., as drinking water) or indirect uses (e.g., crop and pasture irrigation or livestock watering) of surface water and/or ground water.

Evaluations of the retardation, dispersion, and dilution capabilities and potential contamination pathways of the ground water environment under operating and accident conditions with respect to present and future users should be considered. Potential radiological and nonradiological contaminants affecting ground water in the vicinity of the nuclear plant and beyond the site boundaries should be evaluated. Site-specific adsorption coefficients (e.g., for the subsurface soils and backfills/structural fills, chemistry of the subsurface media, preferential flow in the subsurface and other physiographic conditions) should be assessed to evaluate the most severe impact on users of surface and/or ground water and environment and to calculate a conservative estimate of travel time for the contaminants.

For events that may impact a surface water body, the evaluation should consider the characteristics of the receiving water body. Such characteristics include, among others, direction and flow rate of currents, near and far field mixing and dispersion patterns, thermal differences between the assumed release event and receiving water body, impacts of tidal effects, if applicable, and types of surface water use, usage rates, and location downstream from the point of entry.

The basis of the assumed liquid radioactive source term should be clearly stated and include sufficient information for the staff to perform an independent evaluation or confirmation. The discussions should indicate the type of reactor design forming the basis of the source term and state whether the radioactive material inventories are based on a design's certification or were adjusted (e.g., upward or downward) in whole or in part for designs whose certifications are not yet approved by the NRC at the time that the application was submitted to the NRC.

Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning" (Ref. 34), provides guidance on 10 CFR 20.1406, "Minimization of Contamination," and indicates that applicants should strive to minimize contamination and radioactive waste generation over the total life cycle of a facility, from initial layout and design through procedures for operation and final decontamination and dismantlement at the time of decommissioning. Additional guidance on demonstrating compliance with the requirements of 10 CFR 20.1406 is given in Chapters 11 and 12 of the SRP (Ref. 9).

## **Industrial, Military, and Transportation Facilities**

Accidents at present or projected nearby industrial, military, and transportation facilities may affect the safety of a nuclear power station (see Section 2.2.3 of NUREG-0800). According to 10 CFR 100.21(e), “Potential hazards associated with nearby transportation routes, industrial and military facilities must be evaluated and site parameters established such that potential hazards from such routes and facilities will pose no undue risk to the type of facility proposed to be located at the site.”

Accidents at nearby industrial facilities, such as chemical plants, refineries, mining and quarrying operations, oil or gas wells, or gas and petroleum product storage installations, might produce missiles, shock waves, flammable vapor clouds, toxic chemicals, or incendiary fragments. These accidents might affect the station itself or the station operators in a way that jeopardizes the safety of the station.

Accidents at nearby military facilities, such as munitions storage areas and ordnance test ranges, may threaten station safety. An otherwise unacceptable site may be shown to be acceptable if the cognizant military organization agrees to change the installation or mode of operation to reduce the likelihood or severity of potential accidents involving the nuclear station to an acceptable level.

An accident during the transport of hazardous materials (e.g., by air, waterway, railroad, highway, or pipeline) near a nuclear power plant might generate shock waves, missiles, and toxic or corrosive gases that can affect the safe operation of the station. The consequences of the accident will depend on the proximity of the transportation facility to the site, the nature and maximum quantity of the hazardous material per shipment, and the layout of the nuclear station.

Airports are transportation facilities that pose specialized hazards to nearby nuclear power stations. Potential threats to stations from aircrafts result from the aircraft itself used as a missile and from the secondary effects of a crash (e.g., fire).

The acceptability of a site depends on establishing that (1) an accident at a nearby industrial, military, or transportation facility will not result in radiological consequences that exceed the dose guideline in 10 CFR 50.34(a)(1), or (2) the accident poses no undue risk because it is sufficiently unlikely to occur (less than about  $10^{-7}$  per year). As stated in Section 2.2.3 of NUREG-0800, the identification of design-basis events resulting from the presence of hazardous materials or activities in the vicinity of the plant or plants is acceptable if all postulated types of accidents are included for which the expected rate of occurrence of potential exposures resulting in radiological doses in excess of 10 CFR 50.34(a)(1) as it relates to the requirements of 10 CFR Part 100 is estimated to exceed the NRC staff objective of the order of magnitude of  $10^{-7}$  per year.

Potentially hazardous facilities and activities within 8 km (5 mi) of a proposed site, and major airports within 16 km (10 mi) of a proposed site, should be identified. If a preliminary evaluation of potential accidents at these facilities indicates that the potential hazards from shock waves and missiles approach or exceed those of the design-basis tornado of the region or if potential hazards exist such as flammable vapor clouds, toxic chemicals, or incendiary fragments, the suitability of the site should be determined by a detailed evaluation of the degree of risk imposed by the potential hazard.

The identification of design-basis events resulting from the presence of hazardous materials or activities in the vicinity of a nuclear power station is acceptable if the design-basis events include each postulated type of accident for which a realistic estimate of the probability of occurrence of potential radiation exposures in excess of the dose specified in 10 CFR 50.34(a)(1) exceeds approximately  $10^{-7}$  per year. Because of the difficulty of assigning precise numerical values to the probability of occurrence of

the types of potential hazards generally considered in determining the acceptability of sites for nuclear stations, judgment must be used as to the acceptability of the overall risk presented by an event.

In view of the low-probability events under consideration, the probability of occurrence of the initiating events leading to potential radiological consequences in excess of the dose specified in 10 CFR 50.34(a)(1)(ii)(D)(I) should be based on assumptions that are as realistic as practicable. In addition, because the events under consideration are of such low probability, valid statistical data are often not available to permit accurate quantitative calculation of probabilities. Accordingly, a conservative calculation showing that the probability of occurrence of potential radiation exposure in excess of the value specified in 10 CFR 50.34(a)(1) is approximately  $10^{-6}$  per year is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower.

The effects of design-basis events have been appropriately considered if analyses of the effects of those accidents on the safety-related features of the proposed nuclear power station have been performed and appropriate measures (e.g., hardening, fire protection) have been taken to mitigate the consequences of such events.

The studies described in Section 2.2 of NUREG-0800 should be conducted to evaluate in detail the suitability of a site in regard to potential accidents involving hazardous materials and activities at nearby industrial, military, and transportation facilities. Section 2.2.3 of NUREG-0800 describes the staff's evaluation procedures and criteria for potential accidents in the site vicinity.

Regulatory Guide 1.78, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release" (Ref. 35), describes assumptions acceptable to the NRC staff for use in assessing the habitability of the control room during and after a postulated external release of hazardous chemicals and describes criteria that are generally acceptable to the staff for the protection of the control room operators.

Regulatory Guide 1.91, "Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants" (Ref. 36), describes a method acceptable to the NRC staff for determining distances from a plant to a railway, highway, or navigable waterway beyond which any explosion that might occur on these routes is not likely to adversely affect plant operation or to prevent a safe shutdown.

Section 3.5.1.6 of NUREG-0800 describes review procedures regarding potential aircraft hazards. For further information, see DOE-STD-3014, "Accident Analysis for Aircraft Crash into Hazardous Facilities" (Ref. 37), and Regulatory Guide 1.206.

## Ecological Systems and Biota

Areas of great importance to the local aquatic ecosystem may present major difficulties in assessing potential impacts on populations of important species or ecological systems. Such areas include those used for breeding (e.g., nesting and spawning), wintering, and feeding, as well as areas where there may be seasonally high concentrations of individuals of important species.<sup>9</sup> Where the ecological

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<sup>9</sup> A species, whether animal or plant, is important (for the purpose of this guide) if a specific causal link can be identified between the nuclear power station and the species and if one or more of the following applies:

- a if the species is commercially or recreationally valuable,
- b if the species is endangered or threatened, or

sensitivity of a site under consideration cannot be established from existing information, more detailed studies, as discussed in Regulatory Guide 4.2, might be necessary. Impacts of station construction and operation on the biota and ecological systems may be mitigated by design and operational practices if justifiable relative to costs and benefits. In general, the important considerations in the balancing of costs and benefits are (1) the uniqueness of a habitat or ecological system within the region under consideration and (2) the amount of habitat or ecological system that would be destroyed or disrupted relative to the total amount of the habitat or ecological system present in the region or the vulnerability of the reproductive capacity of important species' populations to the effects of construction and operation of the plant and ancillary facilities.

The alteration of one or more of the existing environmental conditions may render a habitat unsuitable as a breeding or nursery area. In some cases, organisms use identical breeding and nursery areas each year; if the characteristics of the areas are changed, breeding success may be substantially reduced or enhanced. Destruction of part or all of a breeding or nursery area may cause population shifts that result in increased competition for the remaining suitable areas. Such population shifts cannot compensate for the reduced size of the breeding or nursery areas if the remaining suitable area is already occupied by the species. Some species will desert a breeding area because of human activities in proximity to the area, even in the absence of physical disturbance of the actual breeding area.

Of special concern in site selection are those unique or especially rich feeding areas that might be destroyed, degraded, or made inaccessible to important species by station construction or operation. Evaluation of feeding areas in relation to potential construction or operation impacts includes the following considerations: size of the feeding area on site in relation to the total feeding area off site, food density, time of use, location in relation to other habitats, topography relative to access routes, and other factors (including human activities). Site modification may reduce the quality of feeding areas by destruction of a portion of the food base, destruction of cover, or both.

Construction and operation of nuclear power stations can create barriers to migration, occurring mainly in the aquatic environment. Narrow zones of passage for migratory animals in some rivers and estuaries may be restricted or blocked by station operation. Partial or complete blockage of a zone of passage may result from the discharge of heat or chemicals to receiving water bodies or the construction and placement of power station structures in the water body. Strong-swimming aquatic animals often avoid waters of adverse quality, but larval and immature forms are usually moved and dispersed by water currents. It is therefore important in site selection that the routes and times of movement of the immature stages be considered in relation to potential effects.

A detailed assessment of the potential impact on the species population would be required for sites where placement of intake or discharge structures would markedly disrupt normal current patterns in migration paths of important species. Several variables, including site characteristics, intake structure design, and placement of the structures at the site, determine the potential for impingement of organisms on cooling water intake structures and entrainment of organisms through the cooling system.

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- c if the species affects the well-being of some important species within criteria (a) or (b) or if it is critical to the structure and function of a valuable ecological system or is a biological indicator of radionuclides in the environment.

Endangered and threatened species are defined by the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), as amended, as follows: "The term 'endangered species' means any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man. The term 'threatened species' means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Secretary of the Interior periodically publishes lists of endangered and threatened species in the *Federal Register*.

NUREG-1555 (Section 2.4), and Regulatory Guide 4.11, "Terrestrial Environmental Studies for Nuclear Power Stations" (Ref. 38), provide NRC staff guidance on the adequacy of the site with respect to ecological issues and biota.

Site characteristics should be considered relative to design and placement of cooling system features and the potential of the cooling system to hold fish in an area longer than the normal period of migration or to entrap resident populations in areas where they would be adversely affected, either directly or indirectly, by limited food supply or adverse temperatures. Canals or areas where cooling waters are discharged may induce fish to remain in an unnaturally warmed habitat. The cessation of station operation during winter can be lethal to these fish because of an abrupt drop in water temperature.

## **Land Use and Aesthetics**

Appropriate designs and practices can mitigate many impacts on land use at the site and in the site neighborhood arising from construction and operation of the plant, transmission lines, and transportation corridors. Aesthetic impacts can be reduced by selecting sites where existing topography and forests can be used to screen station structures from nearby scenic, historical, or recreational resources. Restoration of natural vegetation, creative landscaping,<sup>10</sup> and the integration of structures with the environment can mitigate adverse visual impacts. The definition of aesthetics needs to include all five senses since land use and aesthetics are interrelated (see Bureau of Land Management, Manual Handbook H-8410-1, "Visual Resource Inventory," issued January 1986 (Ref. 39)).

Preconstruction archeological surveys can usually identify historic sites and action can then be taken to avoid the sites or mitigate the impact to the site. For areas of archeological concern, the Chief Archeologist of the National Park Service is an information source, as are the State Archeologist and the State or Native American Tribal Historic Preservation Officer. Both are responsible for the National Historic Preservation Act activities for a particular State.

Proposed alternative land use might render a site unsuitable for a nuclear power station. For example, lands could be unsuitable if specified by a community (1) as planned for other uses or (2) as restricted to compatible uses vis-à-vis other lands. Therefore, official land use plans developed by governments at any level and by regional agencies should be consulted for possible conflicts with power station siting. The Council on Environmental Quality has published a list of Federal agencies that have jurisdiction or expertise in land use planning, regulation, or management.<sup>11</sup>

Another class of impacts involves the preempting of existing land use at the site itself. For example, nuclear power station siting in areas uniquely suited for growing specialty crops may be considered a type of land conversion involving unacceptable economic dislocation. Under 7 CFR Part 1491, "Farm and Ranch Lands Protection Program" (Ref. 40), working agricultural lands are protected from conversion to nonagricultural use. Since power reactor sites under consideration are likely to be in rural areas and potentially under cultivation, this regulation might apply in determinations of site suitability.

Sites adjacent to lands devoted to public use might be considered unsuitable. In particular, the use of some sites or transmission lines or transportation corridors close to special areas administered by Federal, State, or local agencies for scenic or recreational use might cause unacceptable impacts regardless of design parameters. Such cases are most apt to arise in areas adjacent to natural-resource-

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<sup>10</sup> Station protection requirements for nuclear safeguards may influence landscape design and clearing of vegetation.

<sup>11</sup> See U.S. Council on Environmental Quality, "National Environmental Policy Act (NEPA) Implementation Procedures; Appendixes I, II, and III," 49 FR 49750, December 21, 1984.

oriented areas (e.g., Yellowstone National Park) as opposed to recreation-oriented areas (e.g., Lake Mead National Recreation Area). Some historical and archeological sites might also fall into this category. The acceptability of sites near special areas of public use should be determined by consulting cognizant government agencies.

The following are some of the Federal agencies that should be consulted for the special areas listed:

- National Park Service (U.S. Department of the Interior)  
National Parks; International Parks; National Memorial Parks; National Battlefields, Battlefield Parks, and Battlefield Sites; National Military Parks; Historic Areas and National Historic Sites; National Capital Parks; National Monuments and Cemeteries; National Seashores and Lakeshores; National Rivers and Scenic Riverways; National Recreation Areas; National Scenic Trails and Scientific Reserves; National Parkways
- National Park Service Preservation Program  
National Landmarks Program; Historic American Buildings Survey; National Register of Historic Places; National Historical Landmarks Program; National Park Service Archeological Program
- Bureau of Sport Fisheries and Wildlife (U.S. Department of Interior)  
National Wildlife Refuges
- Forest Service (U.S. Department of Agriculture)  
National Forest Wilderness, Primitive Areas, National Forests

Individual States and local governments administer parks, recreation areas, and other public use and benefit areas. Information on these areas should be obtained from cognizant State agencies, such as State departments of natural resources. The Advisory Council on Historic Preservation or the appropriate State or Native American tribal historic preservation officer should be contacted for information on historic areas.

It should be recognized that some areas might be unsuitable for siting because of public interest in future dedication to public scenic, recreational, or cultural use. Relatively rare land types such as sand dunes and wetlands are examples. However, the acceptability of sites for nuclear power stations at some future time in these areas will depend on the existing impacts from industrial, commercial, and other developments. NUREG-1555 contains additional guidance for NRC staff reviews for land use and aesthetics, and RS-002 provides guidance on State and local interaction in land use planning issues and land use control topics.

## **Socioeconomics**

Social and economic issues are important determinants of siting policy. It is difficult both to assess the nature of the impacts involved and to determine value schemes for predicting the level or the acceptability of potential impacts.

The siting, construction, and operation of a nuclear power station might have significant impacts on the socioeconomic structure of a community and might place severe stresses on the local labor supply, transportation facilities, and community services in general. The tax basis and community expenditures might change, and problems might occur in determining equitable levels of compensation for persons relocated as a result of the station siting. It is usually possible to resolve such difficulties by proper coordination with the affected communities; however, some impacts might be locally unacceptable and

too costly to avoid by any reasonable program for their mitigation. Evaluation of the suitability of a site should therefore include consideration of purpose and probable adequacy of socioeconomic impact mitigation plans for such economic impacts on any community where local acceptance problems can be reasonably foreseen.

Certain communities in the neighborhood of a site might be subject to unusual impacts that would be excessively costly to mitigate. Among such communities are towns that possess notably distinctive cultural character (i.e., towns that have preserved or restored numerous places of historic interest, have specialized in an unusual industry or a vocational activity, or have otherwise markedly distinguished themselves from other communities). NUREG-1555 contains additional guidance on NRC staff reviews of socioeconomic issues.

## Environmental Justice

Siting decisions should reflect fair treatment and meaningful involvement of all people, regardless of race, ethnicity, culture, income, or educational level to ensure equitable consideration, including an analysis to determine whether there are any significant impacts that will fall disproportionately on minority communities and low-income communities.<sup>12</sup> The determination of whether a proposed power reactor siting action would disproportionately and adversely affect a minority community or a low-income community might involve the assembly and analysis of considerable quantitative data. Because of the depth of the analysis, the environmental justice aspects often rival the length and complexity of the discussion of the general population in the socioeconomics context. “Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions,” (69 FR 52040), (Ref. 41) and NUREG-1555 contain additional guidance on NRC staff reviews of environmental justice issues.

## Noise

Noise levels at nuclear stations during both the construction and operation phases could have unacceptable impacts. Cooling towers, turbines, and transformers contribute to the noise levels during station operation.

## Limited Work Authorization

In 2007, the NRC amended 10 CFR 50.10 regarding limited work authorizations (LWAs) to allow certain construction activities to commence before a construction permit or combined operating license is issued (72 FR 57416). In particular, the NRC modified the definition of “construction” to eliminate (a) preparation of a site for construction (clearing, grading, installation of environmental mitigation measures, construction of temporary roads and borrow areas), (b) excavation, (c) erection of support buildings, and (d) building of service facilities (paved roads, parking lots, railroad spurs, sewage treatment facilities, and transmission lines). The activities above, which are considered “preconstruction” activities are not under the NRC’s regulatory jurisdiction, are evaluated as part of the cumulative impact analysis. The preconstruction impacts are considered as cumulative impacts.

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<sup>12</sup> “Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions,” (69 FR 52040, 52048), (Ref. 41). This policy statement states that the NRC is committed to the general goals of Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations” (59 FR 7629) (Ref. 42) and “will strive to meet those goals through its normal and traditional NEPA review process.” 69 FR 52040; *see also* 69 FR 52046-48. Executive Order 12898 requires an agency to analyze disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. Executive Order 12898 is not binding upon the NRC as the NRC is an independent regulatory agency. E.O. 12898, § 6-604 (“Independent agencies are *requested* to comply with the provisions of this order”) (emphasis added).

Cumulative impact is the impact on the environment that 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 preceding cumulative impact definition appears in the regulations of the Council on Environmental Quality implementing NEPA (40 CFR 1508.7). NRC regulations state that 40 CFR 1508.7 will be used by the NRC in implementing NEPA [10 CFR 51.14(b)]. Specifically, cumulative impacts include those resulting from preconstruction, construction, operation, and decommissioning of the proposed nuclear power plant, and past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.

## C. STAFF REGULATORY GUIDANCE

### 1. Geology and Seismology

Determination of the seismic, meteorologic, hydrologic, and geologic characteristics of the proposed site should consider the *most severe* of the natural phenomena that have been historically reported for the site and surrounding area and include sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated (see 10 CFR 52.17). Regulatory Guide 1.208 discusses the level of complexity of investigations and design considerations recommended for areas of high earthquake potential. Because of the uncertainties and difficulties in mitigating the effects of permanent ground displacement phenomena such as surface faulting or folding, fault creep, subsidence or collapse, the NRC staff considers it prudent to select an alternative site when the potential for permanent ground displacement exists at the site.

Sites located near geologic structures for which, at the time of application, the database is inadequate to determine their potential for causing surface deformation (e.g., paleoliquefaction features, possible active faults, poor soil zones, tectonic and nontectonic deformation, manmade activities such as withdrawal or injection of fluids, issues related to mineral extraction, induced seismicity caused by reservoir impoundment) are likely to be subject to a longer licensing process. The longer process might be needed to allow for extensive and detailed geologic and seismic investigations of the site and surrounding region and for rigorous analyses of the site-plant combination.

Sites with competent bedrock generally have suitable foundation conditions. In regions with few or no such sites, it is prudent to select sites with competent and stable solid soils, such as dense sands and glacial tills. Other materials might also provide satisfactory foundation conditions, but a detailed geologic and geotechnical investigation should be conducted to determine static and dynamic engineering properties of the material underlying the site in accordance with 10 CFR 100.23.

### 2. Atmospheric Extremes and Dispersion under Accident Conditions and During Normal Plant Operation

As noted in the discussion section of this guide, the potential effects of natural atmospheric extremes and the regional climatology and local meteorology on the safety-related structures of a nuclear station should be considered. Regulatory Guide 1.76 and NUREG-0800 provide guidance in these areas. Data and studies on longer term weather cycles should be examined because of the potential impact of climate change as it applies to nuclear safety and the environment. Site atmospheric conditions are site suitability characteristics, principally with respect to the calculation of radiation doses resulting from the release of fission products as a consequence of a postulated accident. Accordingly, each applicant for site

approval should collect, for at least 1 year, meteorological information that is representative of the site conditions, including windspeed, wind direction, precipitation, and atmospheric stability.

Nonradiological atmospheric considerations, such as local fogging and icing, cooling tower drift, cooling tower plume lengths, and plume interactions between cooling tower plumes, as well as plumes from nearby industrial facilities, should be considered in evaluating the suitability of potential sites. NUREG-1555 offers guidance for evaluating fogging and icing induced by nuclear power plants and the physical and aesthetic impacts of cloud formation, cloud shadowing, additional precipitation, and increased ground-level humidity. Regulatory Guide 1.23 describes the atmospheric data that the staff considers acceptable for the assessment of nonradiological considerations, while NUREG-0800, Section 2.3.3, describes NRC staff review procedures and acceptance criteria for meteorological monitoring.

Under 10 CFR Part 100.21(c)(1), an applicant must demonstrate that radiological airborne effluent release limits can be met for any individual located offsite for the proposed type of reactor facility under normal operation. Radioactive releases and doses associated with routine releases and anticipated operational occurrences of airborne radioactive materials must be kept “as low as is reasonably achievable” (ALARA) (see 10 CFR 20.1101(b)), and must comply with effluent concentration limits of Appendix B to 10 CFR Part 20 and dose limits for members of the public under 10 CFR 20.1301 and 20.1302. In addition, 10 CFR 20.1301(e) requires compliance with EPA’s generally applicable environmental radiation standards of 40 CFR Part 190 for licensees subject to these EPA regulations. The design objectives requirements for equipment to be installed to control releases of radioactive materials in effluents from nuclear power reactors are set forth in 10 CFR 50.34a and General Design Criteria (GDC) 60 and 64 in Appendix A to 10 CFR Part 50. GDC 60 requires the nuclear power unit design to include means to control radioactive effluents, and GDC 64 requires there be means provided to monitor radioactive materials in effluents and in the vicinity of operating reactors. Appendix I, “Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion ‘As Low as is Reasonably Achievable’ for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents,” to 10 CFR Part 50 provides guidance on the requirements for design objectives and technical specification for limiting conditions for operation for light-water-cooled nuclear power plants. Further, 10 CFR 50.36a(a) provides that, to keep power reactor effluent releases ALARA, each license authorizing operation of such a facility will include technical specifications regarding the establishment of operating procedures to control effluents and yearly reporting of actual releases. Additional guidance on how to demonstrate compliance with these requirements is given in Chapter 11 of the SRP (Ref. 8). The SRP guidance refers to specific regulatory guides, computer codes, documents (as NUREGs, generic letters, bulletins, etc.), and industry standards.

The basis of the assumed gaseous effluent radioactive source term should be clearly stated and include sufficient information for the staff to perform an independent evaluation or confirmation. The discussions should indicate the type of reactor design forming the basis of the source term and should state whether the radioactive material inventories are based on a design’s certification or were adjusted (e.g., upward or downward) in whole or in part for designs whose certifications are not yet approved by the NRC at the time that the application was submitted to the NRC.

For gaseous effluent releases, the discussion on atmospheric dispersion and deposition parameters should recognize that in some instances, releases will occur from multiple discharge points (e.g., Reactor-Bldg, Turbine-Bldg, and Radwaste-Bldg) versus a single plant discharge stack. In such instances, the discussion should note whether there is a need to consider three sets of X/Q and D/Q values and radioactive source terms for each building stack or to derive a single effective set of dispersion and deposition parameters that encompass all release points and applied to the sum of individual source terms. The applicant should include sufficient information for the staff to perform an independent evaluation or confirmation.

In identifying offsite dose receptors, the discussion should recognize that in some situations, the dose receptor and exposure pathways identified and evaluated in the initial application might in fact change at some future time. Such changes would be identified during the conduct of yearly land-use census at sites with collocated operating power plants or as part of an environmental monitoring program implemented at green field sites. As a result, the applicant should acknowledge such possibilities and commit to identify and evaluate exposure pathways and dose receptors not identified in the current application. For example, the acknowledgement might state that exposures associated with beef cattle were not considered because there are no nearby cattle ranches. However, should local land-use information reveal that cattle ranching is now being practiced, the applicant would need to consider this pathway and confirm that the associated doses are in compliance with Part 50, Appendix I numerical guides for keeping gaseous and liquid effluents ALARA. The acknowledgement would identify the need to provide the appropriate set of atmospheric dispersion and deposition parameters, as described earlier, for all newly identified exposure locations and pathways.

### 3. Exclusion Area and Low-Population Zone

An applicant for a reactor license is required by 10 CFR Part 100 to designate an exclusion area and to have authority to determine all activities within that area, including removal of personnel and property. Transportation corridors such as highways, railroads, and waterways are permitted to traverse the exclusion area provided (1) these are not so close to the facility as to interfere with normal operation of the facility and (2) appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway in the case of emergency to protect public health and safety.

According to 10 CFR 50.34(a)(1)(ii)(D)(1), the exclusion area must be of such a size that an individual assumed to be located at any point on its boundary would not receive a radiation dose in excess of 25 rem TEDE over any 2-hour period following a postulated fission product release into the containment.

The regulations in 10 CFR Part 100 also require an applicant to designate an area immediately beyond the exclusion area as an LPZ. The size of the LPZ must be such that the distance to the nearest boundary of a densely populated center containing more than about 25,000 residents (“population center distance”) must be at least one-and-one-third times the distance from the reactor to the outer boundary of the LPZ. The boundary of the population center should be determined based on population distribution, not political boundaries.

According to 10 CFR 50.34(a)(1)(ii)(D)(2), the LPZ must be of such a size that an individual located on its outer radius for the course of the postulated accident would not receive a radiation dose in excess of 25 rem TEDE.

Technical requirements for an ESP for a proposed site are contained in 10 CFR 52.17. The technical contents for a combined license (COL) are specified in 10 CFR 52.79. Requirements for site location, facility location within the site, population considerations, and location of nearby facilities (as it relates to postulated releases in the event of an accident) should be evaluated according to the provisions of 10 CFR 52.17 for an ESP and 10 CFR 52.79 for a COL.

### 4. Population Considerations

As stated in 10 CFR 100.21(h), “Reactor sites should be located away from very densely populated centers. Areas of low population density are, generally, preferred. However, in determining the acceptability of a particular site located away from a very densely populated center but not in an area

of low density, consideration will be given to safety, environmental, economic, or other factors, which may result in the site being found acceptable.”

Locating reactors away from densely populated centers is part of the NRC’s defense-in-depth philosophy and facilitates emergency planning and preparedness, as well as reduces potential doses and property damage in the event of a severe accident. Numerical values in this guide are generally consistent with past NRC practice and reflect consideration of severe accidents, as well as the demographic and geographic conditions characteristic of the United States.

A reactor should be located so that, at the time of initial plant approval (to be consistent with Regulatory Guide 1.206 and Section 2.1.3 of NUREG-0800) and within about 5 years thereafter, the population density, including weighted transient population, averaged over any radial distance out to 20 mi (cumulative population at a distance divided by the circular area at that distance), does not exceed 500 persons per square mile. A reactor should not be located at a site where the population density is well in excess of this value.

If the population density of the proposed site exceeds, but is not well in excess of the above preferred value, the analysis of alternative sites should pay particular attention to alternative sites with lower population density. However, consideration of other factors, such as safety, environmental, or economic concerns, may result in the site with the higher population density being found acceptable. Examples of such factors include, but are not limited to, the higher population density site having superior seismic characteristics, better rail or highway access, shorter transmission line requirements, or less environmental impact on undeveloped areas, wetlands, or endangered species.

The transient population should be included for those sites where many people (other than those just passing through the area) work, reside part time, or engage in recreational activities but are not permanent residents of the area. The transient population should be considered for site evaluation purposes by weighting the transient population according to the fraction of time that the transients are in the area.

Population data should be estimated in relation to the time of initial plant approval rather than initial site approval, as noted above. Population projections should be considered over the lifetime of the facility. This is consistent with RS-002, Section 2.3. Further population projections should be made by decade for a 40-year period beyond the start of power plant operation as described in Regulatory Guide 1.206. Projected changes in population within about 5 years after initial plant approval should be evaluated for the proposed site and any alternative sites considered. Population growth in the site vicinity after initial plant approval is normal and expected and should be periodically factored into the emergency plan for the site, but population increases after initial plant approval should not be a factor in license renewal or, by itself, used to impose other license conditions or restrictions on an operating plant.

## 5. Emergency Planning

As stated in 10 CFR 100.21(g), “Physical characteristics unique to the proposed site that could pose a significant impediment to the development of emergency plans must be identified.” 10 CFR 50.47(a)(1)(i) requires a reasonable assurance finding that adequate protective measures can and will be taken in the event of a radiological emergency before the NRC can issue an operating license for a nuclear power plant.

The site and its vicinity, including the population distribution and transportation routes, should be examined and evaluated to determine whether there are any characteristics that would pose a significant impediment to taking actions to protect the public in an emergency. As authorized in

10 CFR 52.17(b)(2)(ii), a proposed site that is contiguous with an existing nuclear power plant site should be evaluated for the complete and integrated emergency plans that would be necessary for construction and operation of one or more reactors at the proposed site (see also Ref. 22). For green-field siting of nuclear power plants, factors important for emergency plans for one or more reactors should be evaluated (see Refs. 19 and 21).

Special population groups, such as those in hospitals, prisons, schools, or other facilities, that could have special needs during an emergency should be identified.

Physical characteristics of the proposed site that could pose a significant impediment to taking protective measures, such as egress limitations from the area surrounding the site, should be identified.

An evacuation time estimate (ETE) must be made for the time that would be required to evacuate various sectors of the plume exposure EPZ, including the entire EPZ. The ETE is an emergency planning tool that assesses, in an organized and systematic fashion, the feasibility of taking protective measures for the population in the surrounding area. NUREG/CR 7002, "Criteria for Development of Evacuation Time Estimate Studies," (Ref 43) gives information on performing an ETE analysis. The value of the ETE analysis lies in the methodology required to perform the analysis rather than in the calculated ETE times. While lower ETEs might reflect favorable site characteristics from an emergency planning standpoint, the regulations do not specify a minimum required evacuation time that an applicant must meet.

## 6. Security

ESP applicants must comply with 10 CFR 52.17(a)(1)(x) and 10 CFR 100.21(f), and should submit applications consistent with the SRP. Information provided by the applicant should be located in section 13.6 Security of the ESP application.

## 7. Hydrology

### 7.1 *Flooding*

To evaluate sites located in river valleys, on flood plains, or along coastlines where there is a potential for flooding, the site suitability studies described in Regulatory Guide 1.59 should be conducted.

### 7.2 *Water Availability*

A highly dependable system of water supply sources should be shown to be available during postulated occurrences of natural and site-related accidental phenomena or combinations of such phenomena as discussed in Regulatory Guide 1.59.

To evaluate the suitability of sites, there should be reasonable assurance that the applicant can obtain, from the appropriate State, local, or regional agency, permits for consumptive use of water in the quantities needed for a nuclear power plant of the stated approximate capacity and type of cooling system. Statistical techniques (e.g., the 7Q10 low-flow condition) should be used to extend and complement the period of record to help identify the expected minimum low flow for the region. If the 7Q10 is too low to supply adequate water for the plant, then other sources of water for nonsafety-related and safety-related structures and ultimate heat sink requirements would need to be identified.

### 7.3 *Water Quality*

The potential impacts of nuclear power stations on water quality are likely to be acceptable if effluent limitations, water quality criteria for receiving waters, and other requirements promulgated pursuant to the FWPCA are applicable and satisfied.

The NRC staff will use the criteria in 10 CFR Part 20 and 10 CFR Part 50 to determine permissible concentrations of radioactive materials discharged to surface water or to ground water.<sup>13</sup>

### 7.4 *Radionuclide Retention and Transport*

To be able to assess radionuclide retention and transportation via ground water, the following information should be determined for the site:

- (1) soil, sediment, and rock characteristics (e.g., grain size, hydraulic conductivity, fracturing),
- (2) source of radioactivity, radionuclide and radioactivity inventories, and assumed release mechanism from the nuclear island, taking into account plant design features,
- (3) adsorption and retardation coefficients for radioactive materials,
- (4) ground water velocity if ground water is impacted,
- (5) dispersion and dilution processes in surface water bodies if surface water is impacted,
- (6) distance to the nearest offsite point of entry in a surface water body or ground water resources, and
- (7) environmental transport mechanisms and exposure pathways leading to direct uses (e.g., as drinking water) or indirect uses (e.g., crop and pasture irrigation or livestock watering) of surface water and/or ground water.

Site-specific adsorption coefficients for radionuclides of concern in the subsurface soils and backfills/structural fills, chemistry of the subsurface media, preferential flow in the subsurface, and other physiographic conditions should be determined to evaluate the most severe impact on people and the environment and to calculate a conservative estimate of travel time for the contaminants. For site suitability studies, a conceptual ground water site model should be developed to identify potential migration and ground water transport pathways for events with the potential to cause environmental contamination. Similarly, if a surface water body is assumed to be impacted, the evaluation should consider the characteristics and associated parameters of the receiving water body. For example, such characteristics include, among others, direction and flow rate of currents, near and far field mixing and dispersion patterns, thermal differences between the assumed release event and receiving water body, impacts of tidal effects, if applicable, and types of surface water use, usage rates, and location downstream from the point of entry.

Aquifers that are or could be used by large populations for domestic, municipal, industrial, or irrigation water supplies provide potential pathways for the transport of radioactive material to man in the event of an accident or of chronic leaks. To evaluate the suitability of proposed sites located over such aquifers, detailed studies of factors identified in Section 2.4.13 of Regulatory Guide 1.206, SRP Section 11.2, and Branch Technical Position (BTP) 11-6 (Ref. 9) should be reviewed and considered in the evaluation. When choosing sites within areas that EPA has designated as an SSA or a site that has the potential to be designated as an SSA in the future, detailed justification based on potential impacts to the affected community should be provided.

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<sup>13</sup> Appendix I to 10 CFR Part 50 provides guidance on the requirements for design objectives and technical specification for limiting conditions for operation for light-water-cooled nuclear power stations.

## 8. Industrial, Military, and Transportation Facilities

According to 10 CFR 100.21(e), “Potential hazards associated with nearby transportation routes, industrial and military facilities must be evaluated and site parameters established such that potential hazards from such routes and facilities will pose no undue risk to the type of facility proposed to be located at the site.”

The acceptability of a site would depend on establishing that (1) an accident at a nearby industrial, military, or transportation facility would not result in radiological consequences that exceed the dose specified in 10 CFR 50.34, or (2) the accident poses no undue risk because it is sufficiently unlikely to occur (less than about  $10^{-7}$  per year). As stated in Section 2.2.3 of NUREG-0800, the identification of design-basis events resulting from the presence of hazardous materials or activities in the vicinity of the plant or plants is acceptable if all postulated types of accidents are included for which the expected rate of occurrence of potential exposures resulting in radiological doses in excess of 10 CFR 50.34(a)(1) as it relates to the requirements of 10 CFR Part 100, is estimated to exceed the NRC staff objective of the order of magnitude of  $10^{-7}$  per year.

Potentially hazardous facilities and activities within 8 km (5 mi) of a proposed site, and major airports within 16 km (10 mi) of a proposed site, should be identified. If a preliminary evaluation of potential accidents at these facilities indicates that the potential hazards from shock waves and missiles approach or exceed those of the design-basis tornado for the region or there are potential hazards such as flammable vapor clouds, toxic chemicals, or incendiary fragments, the suitability of the site should be determined by detailed evaluation of the degree of risk imposed by the potential hazard. Regulatory Guide 1.76 describes the design-basis tornado.

The identification of design-basis events resulting from the presence of hazardous materials or activities in the vicinity of a nuclear power station is acceptable if the design-basis events include each postulated type of accident for which a realistic estimate of the probability of occurrence of doses in excess of the value specified in 10 CFR 50.34(a)(1) exceeds approximately  $10^{-7}$  per year. Because of the difficulty of assigning precise numerical values to the probability of occurrence of the types of potential hazards generally considered in determining the acceptability of sites for nuclear stations, judgment should be used as to the acceptability of the overall risk presented by an event.

In view of the low-probability events under consideration, the probability of occurrence of initiating events leading to potential consequences in excess of the dose specified in 10 CFR 50.34(a)(1) should be based on assumptions that are as realistic as practicable. Because the events being considered are of such low probability, valid statistical data are often not available to permit accurate quantitative calculation of probabilities. Accordingly, a conservative calculation showing that the probability of occurrence of doses in excess of the value specified in 10 CFR 50.34(a)(1) is approximately  $10^{-6}$  per year is acceptable if, when combined with reasonable qualitative arguments, the realistic probability can be shown to be lower.

The effects of design-basis events have been appropriately considered if analyses of the effects of those accidents on the safety-related features of a proposed nuclear station have been performed and appropriate measures (e.g., hardening, fire protection) have been proposed to mitigate the consequences of such events. If there are unusual site characteristics, plant design features, or other factors, then different assumptions might be considered on an individual case basis. In such cases, analyses should conform to the recommendations for radiological design-basis accidents found in applicable sections of Regulatory Guides 1.3, 1.4, and 1.183. For potential aircraft hazards, NUREG-0800 and Regulatory Guide 1.206 present relevant guidance.

## 9. Ecological Systems and Biota

The ecological systems and biota at potential sites and their environs should be sufficiently well known to allow reasonably certain predictions that the construction or operation of a nuclear power station at the site would have no unacceptable or unnecessary deleterious impacts on populations of important species or on the ecological systems with which they are associated. Where the ecological sensitivity of a site cannot be established from existing information, more detailed studies, as discussed in Regulatory Guide 4.2, should be conducted.

When early site inspections and evaluations indicate that critical or exceptionally complex ecological systems will have to be studied in detail to determine the appropriate plant designs, proposals to use such sites should be deferred unless sites with less complex characteristics are not available.

It should be determined whether any important species (as defined in the “Discussion” section of this guide under “Ecological Systems and Biota”) inhabit or use the proposed site or its environs. If so, the relative abundance and distribution of their populations should be considered. Potential adverse impacts on important species should be identified and assessed. The relative abundance of individuals of an important species inhabiting a potential site should be compared to available information in the literature concerning the total estimated local population. Any predicted impacts on the species should be evaluated relative to effects on the local population and the total population of the species. The destruction of, or sublethal effects on, a number of individuals that would not adversely affect the reproductive capacity and vitality of a population or the crop of an economically important harvestable population or recreationally important population should generally be acceptable, except in the case of certain endangered species. If there are endangered or threatened species at a site, the potential effects should be evaluated relative to the impact on the local population and the total estimated population over the entire range of the species as noted in the literature.

Any important ecological systems at a site or in its environs should be identified. If such systems are present, a determination should be made as to whether the ecological systems are especially vulnerable to change or if they contain important species habitats, such as breeding areas (e.g., nesting and spawning areas), nursery, feeding, resting, and wintering areas, or other areas of seasonally high concentrations of individuals of important species.

Important considerations in balancing costs and benefits include the uniqueness of a habitat or ecological system within the region under consideration, the amount of the habitat or ecological system destroyed or disrupted relative to the total amount in the region, and the vulnerability of the reproductive capacity of important species populations to the effects of construction and operation of the station and ancillary facilities.

If sites contain, are adjacent to, or could have an impact on important ecological systems or habitats (e.g., wetlands and estuaries) that are unique, limited in extent, or necessary to the productivity of populations of important species, they cannot be evaluated as to suitability for a nuclear power station until adequate assessments for the reliable prediction of impacts have been completed and the facility design characteristics that would satisfactorily mitigate the potential ecological impacts have been defined. In areas where reliable and sufficient data are not available, the collection and evaluation of appropriate seasonal data may be required.

Migrations of important species and migration routes that pass through the site or its environs should be identified. Generally, the most critical migratory routes relative to nuclear power station siting are those of aquatic species in water bodies associated with the cooling systems. Site conditions that should be identified and evaluated in assessing potential impacts on important aquatic migratory species

include (1) narrow zones of passage, (2) migration periods that are coincident with maximum ambient temperatures, (3) the potential for major modification of currents by station structures, (4) the potential for increased turbidity during construction, and (5) the potential for entrapment, entrainment, or impingement by or in the cooling water system or for blocking of migration by facility structures or effluents.

The potential for blockage of movements of important terrestrial animal populations caused by the use of the site for a nuclear power station and the availability of alternative routes that would provide for maintenance of the species' breeding population should be assessed.

If justifiable relative to costs and benefits, the potential impacts of plant construction and operation on the biota and ecological systems can generally be mitigated by adequate engineering design and site planning and by proper construction and operations when there is adequate information about the vulnerability of the important species and ecological systems.

NUREG-1555 and Regulatory Guide 4.11 provide a list of studies recommended in the area of ecological systems and biological resources, including discussions of potential species and habitat protection under State, local, and Native American governance. Appendix B to this guide summarizes environmental considerations, parameters, and regulatory positions for use in evaluating sites for nuclear power stations.

## 10. Land Use and Aesthetics

Land use plans adopted by Federal, State, regional, or local agencies should be examined, and any conflict between these plans and use of a potential site should be resolved by consultation with the appropriate agency.

For a potential site on land devoted to specialty crop production where changes in land use might result in market dislocations, a detailed investigation should be conducted to demonstrate that potential impacts have been identified.

The potential aesthetic impact of nuclear power stations at sites near natural-resource-oriented public use areas is important, and evaluation of such sites is dependent on consideration of the specific station design layout. NUREG-1555 and RS-002 offer guidance for analysis of power plant siting suitability related to land use and aesthetics. The Bureau of Land Management's Manual Handbook H-8410-1 contains information on the impact of land use and aesthetics on all five senses.

## 11. Socioeconomics

The NRC staff considers that an evaluation of the suitability of nuclear power station sites near distinctive communities should demonstrate that the construction and operation of the nuclear station, including transmission and transportation corridors, and potential problems relating to community services, such as schools, police and fire protection, water and sewage, and health facilities, will not adversely affect the distinctive character of the community nor disproportionately affect minority or low-income populations. A preliminary investigation should be made to address environmental justice considerations and to identify and analyze problems that may arise from the proximity of a distinctive community to a proposed site. NUREG-0800 and NUREG-1555 contain analysis of power plant siting suitability related to socioeconomics.

## 12. Environmental Justice

Siting decisions should reflect fair treatment and meaningful involvement of all people, including an analysis to determine whether there are any significant impacts that will fall disproportionately on minority communities or low-income communities. “Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions,” (69 FR 52040), (Ref. 41) and NUREG-1555 contain additional guidance on NRC staff reviews of environmental justice issues.

## 13. Noise

Noise levels at proposed sites must comply with applicable Federal, State, and local noise regulations.

## 14. Limited Work Authorization

The resource areas to be evaluated for cumulative impacts are generally the same ones evaluated in NUREG-1555. However, if the evaluation for a resource area found no impact to that resource from the action, then that specific resource area does not need to be evaluated for cumulative impacts. For each resource area for which there is a direct or indirect impact, applicants should:

- Identify the geographic area and time period to be considered in evaluating the cumulative impact.
- Develop information on the impacts of the proposed action relevant to cumulative impacts within the identified geographic area.
- Identify other past present or reasonably foreseeable actions that have a cumulative impact when added to the proposed action.
- Determine the cumulative impact to the resource area.
- Identify plans (if any) for mitigation of adverse cumulative impacts, or actions to avoid, minimize, or mitigate cumulative impacts.

For each project identified as contributing to the cumulative impacts, applicants should provide a short description of the contribution to the cumulative impact for the resource area being discussed. A table listing the project, the resource affected, and a short description is generally sufficient.

## **D. IMPLEMENTATION**

The purpose of this section is to provide information to applicants for nuclear power reactor construction permits, early site permits, limited work authorizations, and combined licenses on how applicants may use this regulatory guide and how the NRC staff plans to use this regulatory guide.

The methods described in this regulatory guide will be used in evaluating applications for construction permits, early site permits, combined licenses, and limited work authorizations, which includes information under 10 CFR 51.49(b) or (f), with respect to compliance with applicable regulations governing the siting of new nuclear power plants, unless the applicant proposes an acceptable alternative method for complying with those regulations. Methods that differ from those described in this regulatory guide 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 applicable NRC regulations.

The NRC’s consideration of the information provided by (i) the applicant for, or the holder of, an operating license, (ii) the holder of an early site permit who subsequently seeks, under 10 CFR 52.27, a

limited work authorization under 10 CFR 50.10, and (iii) the holder of a combined license, is not a “siting” determination. Therefore, such NRC consideration is neither backfitting nor an action inconsistent with the applicable issue finality requirements in 10 CFR Part 52. This regulatory guide may also be used by applicants for, and holders of, operating licenses and combined licenses to comply with 10 CFR 50.34. The NRC’s consideration of the information provided by the holder of an operating license or combined license to address 10 CFR 50.34 is not a “siting” determination, nor is it considered to be backfitting or an action inconsistent with the applicable issue finality requirements in 10 CFR Part 52.

## REFERENCES<sup>14</sup>

1. 10 CFR Part 100, “Reactor Site Criteria,” U.S. Nuclear Regulatory Commission, Washington, DC.
2. 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” U.S. Nuclear Regulatory Commission, Washington, DC.
3. 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” U.S. Nuclear Regulatory Commission, Washington, DC.
4. 40 CFR Parts 1500–1508, “Regulations for Implementing NEPA,” Council on Environmental Quality, Washington DC.<sup>15</sup>
5. 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” U.S. Nuclear Regulatory Commission, Washington, DC.
6. Regulatory Guide 4.2, “Preparation of Environmental Reports for Nuclear Power Stations,” U.S. Nuclear Regulatory Commission, Washington, DC.
7. NUREG-1555, “Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan,” Revision 1, U.S. Nuclear Regulatory Commission, Washington, DC.
8. IAEA Safety Standard Series No. NS-R-3 “Site Evaluations for Nuclear Installations,” International Atomic Energy Agency, Vienna, Austria.<sup>16</sup>
9. NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” U.S. Nuclear Regulatory Commission, Washington, DC.
10. Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants, LWR Edition,” U.S. Nuclear Regulatory Commission, Washington, DC.
11. Regulatory Guide 1.208, “A Performance-Based Approach To Define the Site-Specific Earthquake Ground Motion,” U.S. Nuclear Regulatory Commission, Washington, DC.
12. Regulatory Guide 1.59, “Design Basis Floods for Nuclear Power Plants,” U.S. Nuclear Regulatory Commission, Washington, DC.
13. Regulatory Guide 1.132, “Site Investigations for Foundations of Nuclear Power Plants,” U.S. Nuclear Regulatory Commission, Washington, DC.

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<sup>14</sup> Publicly available NRC published documents are available electronically through the NRC Library on the NRC’s public Web site at: <http://www.nrc.gov/reading-rm/doc-collections/>. Copies are also available for inspection or copying for a fee from the NRC’s Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD. The PDR’s mailing address is USNRC PDR, Washington, DC 20555; telephone is (301) 415-4737 or (800) 397-4209; fax is (301) 415-3548; and e-mail is [PDR.Resource@nrc.gov](mailto:PDR.Resource@nrc.gov).

<sup>15</sup> [http://ceq.hss.doe.gov/ceq\\_regulations/regulations.html](http://ceq.hss.doe.gov/ceq_regulations/regulations.html).

<sup>16</sup> [http://www-pub.iaea.org/MTCD/publications/PDF/Pub1177\\_web.pdf](http://www-pub.iaea.org/MTCD/publications/PDF/Pub1177_web.pdf)

14. Regulatory Guide 1.138, "Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC.
15. Regulatory Guide 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites," U.S. Nuclear Regulatory Commission, Washington, DC.
16. Regulatory Guide 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC.
17. 10 CFR Part 20, "Standards for Protection Against Radiation," U.S. Nuclear Regulatory Commission, Washington, DC.
18. Regulatory Guide 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC.
19. Review Standard RS-002, "Processing Applications for Early Site Permits," U.S. Nuclear Regulatory Commission, Washington, DC, May 2004.
20. U.S. Department of Energy (DOE), "Report on Lessons Learned from the NP 2010 Early Site Permit Program," Washington, DC, March 26, 2008.<sup>17</sup>
21. NUREG-0654, Supplement 2, "Criteria for Preparation and Evaluation of Radiological Emergency Plans and Preparedness in Support of Nuclear Power Plants: Criteria for Emergency Planning in an Early Site Permit Application," U.S. Nuclear Regulatory Commission, Washington, DC.
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24. American National Standards Institute/American Nuclear Society (ANSI/ANS)-2.8, "Determining Design Basis Flooding at Power Reactor Sites," Washington, DC, 1992.<sup>18</sup>
25. U.S. Department of Energy, STD-1020-2002, "Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities," Washington, DC, January 2002.<sup>19</sup>
26. U.S. Department of Energy, STD-1021-93, "Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems and Components," Change Notice No. 1, Washington, DC, January 1996 (reaffirmed with errata, April 2002).<sup>20</sup>

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<sup>17</sup> <http://www.ne.doe.gov/pdfFiles/FinalReportonESPLessonsLearned.pdf>

<sup>18</sup> Copies of this document may be purchased from the American National Standards Institute (ANSI), 1819 L Street, NW., 6th floor, Washington, DC 20036 [phone: (202) 293-8020]. Purchase information is available through the ANSI Web site at <http://webstore.ansi.org/ansidocstore/>.

<sup>19</sup> <http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/std1020/STD-10202002.pdf>

<sup>20</sup> [http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/std1021/std1021\\_reaf.pdf](http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/std1021/std1021_reaf.pdf)

27. U.S. Department of Energy, STD-1021-94, “Natural Phenomena Hazards Characterization Criteria,” Change Notice No. 1, Washington, DC, January 1996 (reaffirmed with errata, April 2002).<sup>21</sup>
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29. Regulatory Guide 1.27, “Ultimate Heat Sink for Nuclear Power Plants,” U.S. Nuclear Regulatory Commission, Washington, DC.
30. Bedient, P.B., W.F. Huber, and B.E. Vieux, *Hydrology and Floodplain Analysis*, Fourth Edition, Prentice Hall, Upper Saddle River, NJ, July 2007.
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34. Regulatory Guide 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning,” U.S. Nuclear Regulatory Commission, Washington, DC.
35. Regulatory Guide 1.78, “Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release,” U.S. Nuclear Regulatory Commission, Washington, DC.
36. Regulatory Guide 1.91, “Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants,” U.S. Nuclear Regulatory Commission, Washington, DC.
37. U.S. Department of Energy, STD-3014-2006, “Accident Analysis for Aircraft Crash into Hazardous Facilities,” Washington, DC, March 1991.<sup>26</sup>
38. Regulatory Guide 4.11, “Terrestrial Environmental Studies for Nuclear Power Stations,” U.S. Nuclear Regulatory Commission, Washington, DC.

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<sup>21</sup> [http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/std1021/std1021\\_reaf.pdf](http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/std1021/std1021_reaf.pdf)

<sup>22</sup> [http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/std1023/std102395\\_reaf.pdf](http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/std1023/std102395_reaf.pdf)

<sup>23</sup> <http://pubs.usgs.gov/twri/>

<sup>24</sup> [http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr122\\_main\\_02.tpl](http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr122_main_02.tpl)

<sup>25</sup> <http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=8ff337e6a09b5c8eed9dc83bc3772e5a&rgn=div5&view=text&node=40:28.0.1.1.23&idno=40>

<sup>26</sup> <http://www.hss.energy.gov/nuclearsafety/ns/techstds/standard/std3014/std3014.pdf>

39. Bureau of Land Management, Manual Handbook H-8410-1, "Visual Resource Inventory," U.S. Department of the Interior, Washington, DC, January 1986.<sup>27</sup>
40. 7 CFR Part 1491, "Farm and Ranch Lands Protection Program," U.S. Department of Agriculture, Washington, DC.<sup>28</sup>
41. 69 FR 52040, "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions," August 24, 2004.
42. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (59 FR 7629), February 11, 1994.<sup>29</sup>
43. NUREG/CR 7002, "Criteria for development of Evacuation Time Estimate Studies," U.S. Nuclear Regulatory commission, Washington, DC, December 2012.
44. Regulatory Guide 1.5, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Steam Line Break Accident for Boiling Water Reactors (Safety Guide 5)," U.S. Nuclear Regulatory Commission, Washington, DC.
45. Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors (Safety Guide 25)," U.S. Nuclear Regulatory Commission, Washington, DC.

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<sup>27</sup> <http://www.blm.gov/nstc/VRM/8410.html>

<sup>28</sup> [http://edocket.access.gpo.gov/cfr\\_2009/janqtr/pdf/7cfr1491.1.pdf](http://edocket.access.gpo.gov/cfr_2009/janqtr/pdf/7cfr1491.1.pdf)

<sup>29</sup> <http://www.archives.gov/federal-register/executive-orders/pdf/12898.pdf>

## APPENDIX A

### SITE SAFETY CONSIDERATIONS FOR ASSESSING SITE SUITABILITY FOR NUCLEAR POWER STATIONS

This appendix provides a checklist of site safety characteristics, relevant regulations, and regulatory guides and regulatory experience and positions for assessing site suitability for nuclear power stations.

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
<p><b>A.1 Geology/Seismology</b></p> <p>Geologic and seismic characteristics of a site, such as surface faulting, ground motion, foundation conditions (including liquefaction, subsidence, and landslide potential), tectonic and nontectonic deformation, and manmade activities may affect the safety of a nuclear power station.</p>	<p>Title 10 of the <i>Code of Federal Regulations</i>, Section 100.23 (10 CFR 100.23), “Geologic and Seismic Siting Criteria”</p> <p>Regulatory Guide 1.208, “A Performance-Based Approach To Define the Site-Specific Earthquake Ground Motion”</p> <p>Regulatory Guide 1.29, “Seismic Design Classification” (discusses plant safety features that should be controlled by engineering design)</p> <p>Regulatory Guide 1.132, “Site Investigations for Foundations of Nuclear Power Plants”</p> <p>Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants, LWR Edition”</p> <p>Regulatory Guide 1.198, “Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites”</p> <p>NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition”</p> <p>See also U.S. Department of Energy (DOE) documents DOE-STD-1020, 1021-93, 1022-94, 1023-95, and 1189-2008 on natural phenomena hazards</p>	<p>Where the potential for permanent ground deformation such as faulting, folding, subsidence, collapse, tectonic and nontectonic deformation, and manmade activities exists at a site, the staff of the U.S. Nuclear Regulatory Commission (NRC) considers it prudent to select an alternative site.</p> <p>Sites should be selected in areas for which an adequate geologic database exists or can be expeditiously developed through site-specific investigations to identify and characterize potential geological and seismic hazards. The seismic and geologic (and meteorologic and hydrologic) characteristics of the proposed site should consider the <i>most severe</i> of the natural phenomena that have been historically reported for the site and surrounding area and include sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. Delay in licensing can result from a need for extensive geologic and seismic investigations. Conservative design of safety-related structures should be presented when geologic, seismic, and foundation information is questionable.</p> <p>Sites with competent bedrock generally have suitable foundation conditions.</p> <p>If bedrock sites are not available, it is prudent to select sites in areas known to have a low subsidence and liquefaction potential. Investigations are required to determine the static</p>

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
		and dynamic engineering properties of the material underlying the site under Appendix A, “Seismic and Geologic Siting Criteria for Nuclear Power Plants,” to 10 CFR Part 100, “Reactor Site Criteria,” and 10 CFR 100.23.
<b>A.2 Atmospheric Dispersion</b>		
<p>The atmospheric conditions at a site should provide sufficient dispersion of radioactive materials released during a postulated accident to reduce the radiation exposures of individuals at the exclusion area and low-population zone boundaries to the values in 10 CFR 50.34, “Contents of Applications; Technical Information.”</p>	<p>10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities”</p> <p>Regulatory Guide 1.23, “Meteorological Monitoring Programs for Nuclear Power Plants”</p> <p>Regulatory Guide 1.145, “Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants”</p> <p>Regulatory Guide 1.3, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors”</p> <p>Regulatory Guide 1.4, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors”</p> <p>Regulatory Guide 1.5, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Steam Line Break Accident for Boiling Water Reactors (Safety Guide 5)” (Ref. 43)</p> <p>Regulatory Guide 1.25, “Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors (Safety Guide 25)” (Ref. 44)</p> <p>NUREG-0800, Section 2.3.3</p> <p>Regulatory Guide 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Plants”</p>	<p>Engineered safety features can compensate for unfavorable, safety-related design-basis atmospheric dispersion characteristics. Accordingly, the regulatory position on atmospheric dispersion of radiological effluents is incorporated in the section “Exclusion Area and Low-Population Zone” (see A.3 of this appendix).</p>

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
<b>A.3 Exclusion Area and Low-Population Zone</b>		
<p>In the event of a postulated accident at a nuclear power station, radiological consequences for individual members of the public outside the station must be acceptably low.</p>	<p>10 CFR Part 100 requires an “exclusion area” surrounding the reactor, in which the reactor licensee has the authority to determine all activities, including exclusion or removal of personnel and property, and a low-population zone (LPZ), which immediately surrounds the exclusion area. The size of the LPZ must be such that the distance to the nearest boundary of a densely populated center with more than 25,000 residents is at least one-and-one-third times the distance from the reactor to the outer boundary of the LPZ.</p> <p>10 CFR Part 50 requires that, at any point on the exclusion area boundary and on the outer boundary of the LPZ, the exposure of an individual to a postulated release of fission products (as a consequence of an accident) be less than 25 rem total effective dose equivalent, for time periods specified in the regulations.</p> <p>Regulatory Guides 1.3, 1.4, 1.5, and 1.25 give calculational methods (see A.2 of this appendix).</p> <p>Regulatory Guide 1.183</p> <p>Regulatory Guide 1.206</p> <p>NUREG-0800, Section 2.1.2</p>	<p>Based on the assumptions in Regulatory Guides 1.3 and 1.4, the required distances to the exclusion area boundary and the outer boundary of the LPZ will depend on plant design aspects, such as the reactor power level, allowable containment leak rate, and those engineered safety features incorporated in the design, as well as the atmospheric dispersion characteristics of the site.</p> <p>Regulatory Guide 1.183 specifies the fractional releases of radiological groups from the core inventory, the timing of the release, their composition, and the chemical form of the alternative source term. It supersedes some of the guidance in Regulatory Guides 1.3, 1.4, 1.5, and 1.25, as it applies to alternate source terms for newer nuclear power plants.</p>
<b>A.4 Population Considerations</b>		
<p>Locating reactors away from densely populated centers is part of the NRC’s defense-in-depth philosophy and facilitates emergency planning and preparedness, as well as reduces potential doses and property damage in the event of a severe accident.</p> <p>Population data are to be estimated in relation to the time of initial plant approval rather than initial site approval.</p>	<p>10 CFR Part 100 provides the following:</p> <ul style="list-style-type: none"> <li>• The applicant must determine an “exclusion area” surrounding the reactor, in which the reactor licensee has the authority to determine all activities, including exclusion or removal of personnel and property, and an LPZ, which immediately surrounds the exclusion area.</li> <li>• The nearest distance to the boundary of a densely populated</li> </ul>	<p>A reactor should preferably be located such that, at the time of initial site approval and within about 5 years thereafter, the population density, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the area at that distance), does not exceed 500 persons per square mile. A reactor should not be located at a site where the population density is well in excess of the above value.</p> <p>If the population density of the</p>

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
<p>Population projections should be made by decade for a 40-year period beyond the start of power plant operations.</p>	<p>center containing more than about 25,000 residents must be at least one-and-one-third times the distance from the reactor to the outer boundary of the LPZ.</p> <ul style="list-style-type: none"> <li>Reactor sites should be located away from very densely populated centers. Areas of low population density are generally preferred. However, in determining the acceptability of a particular site located away from a very densely populated center but not in an area of low density, consideration will be given to safety, environmental, economic, or other factors, which may result in the site being found acceptable.</li> </ul> <p>Regulatory Guide 1.206</p> <p>Review Standard RS-002, "Processing Applications for Early Site Permits," Section 2.1.3, on consideration of projected population over the lifetime of the facility</p> <p>NUREG-0800, Section 2.1.3, on site population distribution</p>	<p>proposed site exceeds, but is not well in excess of, the preferred value, the analysis of alternative sites should pay particular attention to alternative sites with lower population density. Other factors, such as safety, environmental, or economic characteristics, will be considered, which may result in the site with higher population density being found acceptable.</p> <p>Transient population should be included for those sites where many people (other than those just passing through the area) work, reside part time, or engage in recreational activities, but are not permanent residents of the area. The transient population should be considered by weighing the transient population according to the fraction of time the transients are in the area.</p> <p>Population data should be estimated in relation to the time of initial plant approval rather than initial site approval, as recommended in Regulatory Guide 1.206. Population projections should be considered over the lifetime of the facility. This is consistent with RS-002, Section 2.3. Further population projections should be made by decade for a 40-year period beyond the start of power plant operation.</p>
<p><b>A.5 Emergency Planning</b></p>		
<p>To ensure that adequate measures can be taken to protect members of the public in an emergency, the characteristics of the site should not preclude development of such plans.</p>	<p>10 CFR Part 100 requires that site characteristics be such that adequate plans to protect members of the public in an emergency can be developed.</p> <p>10 CFR Part 50 requires the following:</p> <ul style="list-style-type: none"> <li>reasonable assurance that adequate protection can and will be taken in the event of a radiological emergency</li> <li>generally, emergency planning zones (EPZs) consisting of the plume exposure pathway EPZ with an area about 16 kilometers (km) (10 miles (mi)) in radius, and the</li> </ul>	<p>The site should be examined and evaluated to determine whether any characteristics would pose a significant impediment to taking actions to protect the public in an emergency.</p> <p>10 CFR 50.47(a)(1) requires a reasonable assurance finding that adequate protective measures can and will be taken in a radiological emergency. As authorized in 10 CFR 52.17(b)(2)(ii), a proposed site that is contiguous with an existing nuclear power plant site should be evaluated for the complete and integrated emergency plans that</p>

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
	<p>ingestion pathway EPZ with an area about 80 km (50 mi) in radius</p> <p>Regulatory Guide 1.206, Section C.I.13.3, on the relevance of population distributions in emergency planning</p> <p>Regulatory Guide 1.183, on the appropriate use of alternate source terms in establishing emergency response procedures such as those for emergency dose projections, protective measures, and severe accident management.</p> <p>NUREG-0654/FEMA-REP-1, Rev. 1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," issued in November 1980, (Ref. 21), for guidance on performing an evacuation time estimate (ETE).</p> <p>NUREG/CR-7002 "Criteria for Development of Evacuation Time Estimate Studies (Ref. 43).</p>	<p>would be necessary for construction and operation of one or more reactors at the proposed site (see also the DOE "Report on Lessons Learned from the NP 2010 Early Site Permit Program," dated March 26, 2008). For green-field siting of nuclear power plants, emergency plans for one or more reactors should be evaluated (see RS-002 and NUREG-0654).</p> <p>Physical characteristics of the proposed site that could pose a significant impediment to taking protective actions, such as egress limitations from the area surrounding the site, should be identified.</p> <p>Special population groups, such as those in hospitals, prisons, schools, or other facilities that could have special needs during an emergency, should be identified.</p> <p>An ETE should be performed to estimate the time that would be required to evacuate various sectors of the plume exposure EPZ, including the entire EPZ. The ETE analysis is an emergency planning tool that assesses, in an organized and systematic fashion, the feasibility of taking protective measures for the population in the surrounding area. While lower ETEs may reflect favorable site characteristics from an emergency planning standpoint, there is no minimum required evacuation time that an applicant must meet.</p>
<b>A.6 Security Plans</b>		
<p>To prevent radiological sabotage, the characteristics and hazards of natural, existing, or proposed man-made features at or located in proximity to a proposed site should not preclude development of adequate security plans.</p>	<p>10 CFR 52.17(a)(1)(xii) requires, in part, that an Early Site Permit (ESP) applicant's site safety analysis report include "an evaluation of the site against applicable sections of the Standard Review Plan (SRP) revision in effect 6 months before the docket date of the application."</p> <p>10 CFR 52.17(a)(1)(x) requires an ESP applicant's site safety analysis report to include information demonstrating that site characteristics are such that adequate security plans</p>	<p>ESP applicants should submit applications consistent with the Standard Review Plans (SRP) (see 10 CFR 52.17(a)(1)(xii)), and information provided by the applicant should be located in section 13.6 Security of the ESP application.</p> <p>The proposed site characteristics and hazards regarding natural, existing, or proposed man-made features at or located in proximity to a proposed site should not preclude development of adequate security plans, and should be examined and identified to</p>

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
	<p>and measures can be developed.</p> <p>10 CFR 100.21(f) requires that site characteristics be such that adequate security plans and measures can be developed.</p> <p>NUREG-0800, Section 13.6.3, “Physical Security – Early Site Permit Review Responsibilities,” Guidance states that the location of transportation routes (e.g., rail, water, and roads), pipelines, airports, hazardous material facilities, and pertinent environmental features should be considered for the implementation of security plans and for potential adverse impacts for response activities related to security operations.</p>	<p>determine if they are characteristics and hazards that will not adversely affect the proposed sites security operations.</p>
<b>A.7 Hydrology</b>		
<b>A.7.1 Flooding</b>		
<p>Precipitation, wind, or seismically induced flooding (e.g., resulting from dam failure, from river blockage or diversion, or from distantly and locally generated sea waves) can affect the safety of a nuclear power station.</p>	<p>10 CFR 100.23</p> <p>Regulatory Guide 1.59, “Design Basis Floods for Nuclear Power Plants”</p> <p>Regulatory Guide 1.206</p> <p>10 CFR Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants;” Criterion 2, “Design Bases for Protection Against Natural Phenomena”</p>	<p>To evaluate sites located in river valleys, on flood plains, or along coastlines where there is a potential for flooding, the studies described in Regulatory Guide 1.59 should be conducted.</p>
<b>A.7.2 Water Availability</b>		
<p>A safety-related water supply is required for normal or emergency shutdown and cooldown.</p>	<p>10 CFR 100.23</p> <p>Regulatory Guide 1.59</p> <p>Regulatory Guide 1.27, “Ultimate Heat Sink for Nuclear Power Plants”</p>	<p>A highly dependable system of water supply sources should be shown to be available under postulated occurrences of natural phenomena and site-related accidental phenomena or combinations of such phenomena as discussed in Regulatory Guide 1.59.</p> <p>To evaluate the suitability of a site, there must be a reasonable assurance finding that the applicant can obtain, from the appropriate State, local, or regional agency, permits for water use and for water consumption in the quantities needed for a nuclear power plant of the stated approximate capacity and type of cooling system.</p>

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
		Statistical techniques (e.g., the 7Q10 low-flow condition) should be used to extend and complement the period of record to help identify the expected minimum low flow for the region. If the 7Q10 is too low to supply adequate water for the plant, then other sources of water for nonsafety-related and safety-related structures and ultimate heat sink requirements should be identified.
<p><b>A.7.3 Water Quality</b></p> <p>Contamination of ground water and surface water by radioactive materials discharged from nuclear stations could cause public health hazards.</p>	<p>10 CFR Part 20, “Standards for Protection Against Radiation”</p> <p>10 CFR Part 50</p> <p>Regulatory Guide 4.21, “Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning”</p>	<p>The NRC staff will use the criteria in 10 CFR Part 20 and 10 CFR Part 50 to determine permissible concentrations of radionuclides discharged to surface water and ground water.</p> <p>For sites within areas that the U.S. Environmental Protection Agency (EPA) has designated as sole source aquifers, or in sites with the potential to be designated a sole source aquifer in the future, detailed justification based on potential impacts to the affected community should be provided.</p> <p>10 CFR 20.1406 requires the minimization (to the extent practicable) of contamination and radioactive waste generation. Regulatory Guide 4.21 explains that applicants should strive to minimize contamination and radioactive waste generation over the total life cycle of a facility, from initial layout and design through procedures for operation and final decontamination and dismantlement at the time of decommissioning.</p>
<p><b>A.8 Industrial, Military, and Transportation Facilities</b></p>		
<p>Accidents at present or projected nearby industrial, military, and transportation facilities may affect the safety of the nuclear power station.</p>	<p>10 CFR 100.21, “Non-seismic Siting Criteria”</p> <p>10 CFR Part 50, Appendix A, Criterion 4, “Environmental and Dynamic Effects Design Bases”</p> <p>Regulatory Guide 1.206</p> <p>Regulatory Guide 1.78, “Evaluating</p>	<p>Potentially hazardous facilities and activities within 8 km (5 mi) and major airports within 16 km (10 mi) of a proposed site should be identified. If a preliminary evaluation of potential accidents at these facilities indicates that the potential hazards from shock waves and</p>

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
	<p>the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release”</p> <p>Regulatory Guide 1.76, “Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants”</p> <p>Regulatory Guide 1.91, “Evaluations of Explosions Postulated To Occur on Transportation Routes Near Nuclear Power Plants”</p> <p>Regulatory Guide 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis”</p> <p>Regulatory Guide 1.183</p> <p>Regulatory Guide 1.206</p>	<p>missiles approach or exceed those of the design-basis tornado for the region, or potential hazards such as flammable vapor clouds, toxic chemicals, or incendiary fragments exist, the suitability of the site should be determined by detailed evaluation of the potential hazard.</p> <p>The acceptability of a site depends on establishing that (1) an accident at a nearby industrial, military, or transportation facility will not result in radiological consequences that exceed the dose specified in 10 CFR 50.34, or (2) the accident poses no undue risk because it is sufficiently unlikely to occur (less than about <math>10^{-7}</math> per year). As stated in Section 2.2.3 of NUREG-0800, the identification of design-basis events resulting from the presence of hazardous materials or activities in the vicinity of the plant or plants is acceptable if all postulated types of accidents are included for which the expected rate of occurrence of potential exposures resulting in radiological doses in excess of 10 CFR 50.34(a)(1) as it relates to the requirements of 10 CFR Part 100, is estimated to exceed the NRC staff objective of the order of magnitude of <math>10^{-7}</math> per year.</p>

## APPENDIX B

### ENVIRONMENTAL PROTECTION CONSIDERATIONS FOR ASSESSING SITE SUITABILITY FOR NUCLEAR POWER STATIONS

This appendix summarizes environmental considerations related to site characteristics that should be addressed in the early site selection process. The relative importance of the different factors to be considered varies with the region or State in which the potential sites are located.

Site selection processes can be facilitated by establishing limits for various parameters based on the best judgment of specialists knowledgeable about the region under consideration. For example, limits can be chosen for the fraction of water that can be diverted in certain situations without adversely affecting the local populations of important species. Although simplistic because important factors such as the distribution of important species in the water body are not considered, such limits can be useful in a screening process for site selection.

Considerations	Parameters	Regulatory Position
<p><b>B.1 Preservation of Important Habitats</b></p> <p>Important habitats are those that are essential to maintaining the reproductive capacity and vitality of important species populations (defined in Section B of this guide under “Ecological Systems and Biota”) or the harvestable crop of economically or recreationally important species. Such habitats include breeding areas (e.g., nesting and spawning areas), nursery, feeding, resting, and wintering areas, wetlands, or other areas of seasonally high concentrations of individuals of important species.</p> <p>The construction and operation of nuclear power stations (including new transmission lines and access corridors constructed in conjunction with the station) can result in the destruction or alteration of habitats of important species, leading to changes in the abundance of a species or in the species composition of a community.</p>	<p>The proportion of an important habitat that would be destroyed or significantly altered in relation to the total habitat within the region where the proposed site is to be located is a useful parameter for estimating potential impacts of the construction or operation of a nuclear power station. This proportion varies among species and among habitats. The region considered in determining proportions is the normal geographic range of the specific population in question.</p> <p>If endangered or threatened species occur at a site, the potential effects of the construction and operation of a nuclear power station should be evaluated relative to the potential impact on the local population and the total estimated population over the entire range of species.</p> <p>See also Chapter 2 of Regulatory Guide 4.2, “Preparation of Environmental Reports for Nuclear Power Stations.”</p> <p>See also the following statutes that provide specific mandates to protect habitats and the species that use them:</p>	<p>In general, a detailed justification should be provided when the destruction or significant alteration of more than a few percent of important habitat types is proposed.</p> <p>The reproductive capacity of populations of important species and the harvestable crop of economically or recreationally important populations should be maintained unless proposed or probable changes can be justified.</p>

Considerations	Parameters	Regulatory Position
	<ul style="list-style-type: none"> <li>• Endangered Species Act of 1973, as amended (16 U.S.C 1531 et seq.)</li> <li>• The Fish and Wild Life Coordination Act, as amended (16 U.S.C. 661 et seq.)</li> <li>• The Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.)</li> <li>• The Migratory Bird Treaty Act of 1972, as amended (16 U.S.C. 703 et seq.)</li> <li>• The Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 et seq.)</li> <li>• Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 U.S.C. 1801 et seq.)</li> </ul>	
<p><b>B.2 Migratory Routes of Important Species</b></p>		
<p>Seasonal or daily migrations are essential to maintaining the reproductive capacity of some important species populations.</p> <p>Disruption of migratory patterns can result from partial or complete blockage of migratory routes by structures, discharge plumes, environmental alterations, or human activities (e.g., transportation or transmission corridor clearing and site preparation).</p>	<p>The width or cross-sectional area of a water body at a proposed site relative to the general width or cross-sectional area in the portion of the water used by migrating species should be estimated. Suggested minimum zones of passage range from one-third to three-fourths of the width or cross-sectional areas of narrow water bodies.<sup>30,31</sup></p> <p>Some species migrate in central, deeper areas while others use marginal, shallow areas. Rivers, streams, and estuaries are seldom homogeneous in their lateral dimension with respect to depth, current velocity, and habitat type. Thus, the use of width or cross-sectional area criteria for determining adequate zones of passage should be combined with knowledge of important species and their migratory requirements.</p> <p>See NUREG-1555, "Standard</p>	<p>Narrow reaches of water bodies should be avoided as sites for locating intake or discharge structures. A zone of passage that will permit normal movement of important species populations and maintenance of the harvestable crop of economically important populations should be provided.</p>

<sup>30</sup> See *Water Quality Criteria*, National Academy of Sciences-National Academy of Engineering, Washington, DC, 1972.

<sup>31</sup> See *Handbook of Environmental Control, Volume III: Water Supply and Treatment*, R.G. Bond and C.P. Straub (Editors), CRS Press, Cleveland, OH, 1973.

Considerations	Parameters	Regulatory Position
	<p>Review Plans for Environmental Reviews for Nuclear Power Plants,” Section 2.4, “Ecology.”</p> <p>See also the following statutes as they relate to migratory routes of important species:</p> <ul style="list-style-type: none"> <li>• The Fish and Wild Life Coordination Act, as amended (16 U.S.C. 661 et seq.)</li> <li>• The Migratory Bird Treaty Act of 1972, as amended (16 U.S.C. 703 et seq.)</li> <li>• Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 U.S.C. 1801 et seq.)</li> </ul>	
<p><b>B.3 Entrainment and Impingement of Aquatic Organisms</b></p>		
<p>Plankton, including eggs, larvae, and juvenile fish, can be killed or injured by entrainment through power station cooling systems or in discharge plumes.</p> <p>The reproductive capacity of important species populations may be impaired by lethal stresses or by sublethal stresses that affect reproduction of individuals or result in increased predation on the affected species population.</p> <p>Fish and other aquatic organisms can be killed or injured by impingement on cooling water intake screens<sup>32</sup> or by entrainment in discharge plumes.</p>	<p>The depth of the water body at the point of intake relative to the general depth of the water body in the vicinity of the site should be considered.</p> <p>The proportion of water withdrawn relative to the net new available water at the site is an indirect measure of the destruction of plankton, which in turn is indicative of possible effects on populations of important species. It has been suggested that the fraction of available new water that can be diverted is in the range of 10 to 20 percent of flow.<sup>33, 34</sup></p> <p>The simplistic parameter (proportion of water withdrawal) is suitable for use in a screening process or site selection. However, other factors, such as distribution of important species, should be considered, and in all cases, experts</p>	<p>The site should have characteristics that allow placement of intake structures where the relative abundance of important species is small and where low approach velocities can be attained. (Deep regions are generally less productive than shallow areas. It is not implied that benthic intakes are necessary.)</p> <p>Important habitats (see B.1 of this Appendix B) should be avoided as locations for intake structures.</p>

<sup>32</sup> Approach velocity and screen-face velocity are design criteria that may affect the impingement of larger organisms, principally fish, on intake screens. Acceptable approach and screen-face velocities are based on swimming speeds of fish, which will vary with the species, site, and season.

<sup>33</sup> See *The Water's Edge: Critical Problems of the Coastal Zone*, B.H. Ketchum (Editor), MIT Press, Cambridge, MA, 1972.

<sup>34</sup> See “Engineering for Resolution of the Energy-Environment Dilemma,” National Academy of Engineering, Washington, DC, 1972.

Considerations	Parameters	Regulatory Position
	<p>on the local fisheries should be consulted to ensure that proposed withdrawals will not be excessive.</p> <p>See NUREG-1555, Section 2.4, "Ecology."</p> <p>See also the following statutes as they relate to entrainment and impingement of aquatic organisms:</p> <ul style="list-style-type: none"> <li>• The Fish and Wild Life Coordination Act, as amended (16 U.S.C. 661 et seq.)</li> <li>• Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 U.S.C. 1801 et seq.)</li> </ul>	
<b>B.4 Entrapment of Aquatic Organisms</b>		
<p>Cooling water intake and discharge system features, such as canals and thermal plumes, can attract and entrap organisms, principally fish. The resulting concentration of important fish species near the station site can result in higher mortalities from station-related causes, such as impingement, cold shock, or gas bubble disease, than would otherwise occur.</p> <p>Entrapment can also interrupt normal migratory patterns.</p>	<p>The site should have characteristics that will accommodate design features that mitigate or prevent entrapment.</p> <p>See NUREG-1555, Section 2.4, "Ecology."</p> <p>See also the following statutes as they relate to entrapment of aquatic organisms:</p> <ul style="list-style-type: none"> <li>• The Fish and Wild Life Coordination Act, as amended (16 U.S.C. 661 et seq.)</li> <li>• Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 U.S.C. 1801 et seq.)</li> </ul>	<p>Sites where the construction of intake or discharge canals would be necessary should be avoided unless the site and important species characteristics are such that entry of important species to the canal can be prevented or limited by screening.</p>
<b>B.5 Water Quality</b>		
<p>Effluents discharged from nuclear power plants are governed under the authority of the Federal Water Pollution Control Act (FWPCA) (PL 92-500).</p>	<p>Applicable State water quality standards approved by EPA.</p> <p>See also the provisions of the FWPCA (33 U.S.C. 661 et seq.) regarding restoring and maintaining the chemical, physical, and biological integrity of the Nation's waters and Title 40 of the <i>Code of Federal Regulations</i>, Part 149, for sole source aquifer designations.</p>	<p>Pursuant to Section 401(a)(1) of the FWPCA (or the Clean Water Act), certification from the State that any discharge will comply with applicable effluent limitations and other water pollution control requirements is necessary before the NRC can issue a construction permit, early site permit, or combined license, unless the requirement is waived by the State or the State fails to act within a reasonable length of time.</p>

Considerations	Parameters	Regulatory Position
		<p>Issuance of a permit pursuant to Section 402 of the FWPCA is not a prerequisite to issuance of an NRC license or permit.</p> <p>Where station construction or operation has the potential to degrade water quality to the possible detriment of other users, more detailed analyses and evaluation of water quality may be necessary.</p>
<b>B.6 Water Availability</b>		
<p>The consumptive use of water for cooling may be restricted by statute, may be inconsistent with water use planning, or may lead to an unacceptable impact to the water resource.</p>	<p>Applicable Federal, State, and local statutory requirements must be met.</p> <p>Compatibility with the water use plan of cognizant water resource planning agency must be achieved.</p> <p>In the absence of a water use plan, the effect on other water users is evaluated, considering flow or volume reduction and the resultant ability of all users to obtain adequate supply and to meet applicable water quality standards (see B.5 of this appendix).</p> <p>See NUREG-0800, Section 2.4.1, for identification of sources of hydrometeorological and streamflow data for determination of an adequate water supply for safety-related structures, systems, and components, and Section 2.4.4, for consideration of loss of water supply and its effects on safety-related structures, systems, and components.</p>	<p>Water use and consumption must comply with statutory requirements and be compatible with water use plans of cognizant water resources planning agencies.</p> <p>Consumptive use should be restricted such that the supply of other users is not impaired and applicable surface water quality standards can be met, assuming normal station operational discharges and extreme low-flow conditions defined by generally accepted engineering practices.</p> <p>For multipurpose impounded lakes and reservoirs, consumptive use should be restricted such that the magnitude and frequency of drawdown will not result in unacceptable damage to important habitats (see B.1 of this appendix) or be inconsistent with the management goals for the water body.</p> <p>Statistical techniques (e.g., the 7Q10 low-flow condition) should be used to extend and complement the period of record to help identify the expected minimum low flow for the region. If the 7Q10 is zero or too low to supply adequate water for the plant, then other sources of water for nonsafety-related and safety-related structures and ultimate heat sink requirements would need to be identified.</p>

<b>Considerations</b>	<b>Parameters</b>	<b>Regulatory Position</b>
<b>B.7 Established Public Resource Areas</b>		
<p>Areas dedicated by Federal, State, or local governments to scenic, recreational, or cultural purposes are generally prohibited areas for siting power stations.</p> <p>Siting nuclear power stations in the vicinity of established public resource areas could result in the loss or deterioration of important public resources.</p>	<p>Proximity to public resource area. See the National Historic Preservation Act, as amended (16 U.S.C. 470 et seq.) in relation to established resource areas.</p> <p>Viewability (see B.10 of this appendix).</p>	<p>Siting in the vicinity of designated public resource areas will generally require extensive evaluation and justification.</p> <p>The evaluation of the suitability of sites in the vicinity of public resource areas is dependent on consideration of a specific plant design and station layout in relation to potential impacts on the public resource area.</p>
<b>B.8 Prospective Designated Resource Areas</b>		
<p>Areas containing important resources for scenic, recreational, or cultural use might not currently be designated as such by public agencies but might involve a net loss to the public if converted to power generation. These areas may include locally rare land types, such as sand dunes, wetlands, or coastal cliffs.</p>	<p>The number and extent of possible resource areas compared with other similar areas available on a local, regional, or national basis, as appropriate. Also, distinct, unique, or rare characteristics, since prospective resource areas are protected by land use plans.</p>	<p>Public resource areas that are distinctive, unique, or rare in a region should be avoided as sites for nuclear power stations.</p> <p>Applicants should consult local agencies if there are no adopted land use plans.</p>
<b>B.9 Public Planning</b>		
<p>Land use for a nuclear power station should be compatible with established land use or zoning plans of governmental agencies.</p>	<p>Officially adopted land use plans.</p>	<p>Land use plans adopted by Federal, State, regional, or local agencies must be examined, and any conflict between these plans and use of a proposed site must be resolved by consultation with the appropriate governmental entity.</p>
<b>B.10 Visual Resources</b>		
<p>The presence of power station structures may introduce adverse visual impacts on residential, recreational, scenic, or cultural areas or other areas with significant dependence on desirable viewing characteristics.</p>	<p>The solid angle subtended by station structures at critical viewing points.</p> <p>The definition of “aesthetics” needs to include all five senses, since land use and aesthetics are interrelated (see Bureau of Land Management, Manual Handbook H-8410-1, “Visual Resource Inventory,” issued in January 1986).</p>	<p>The visual intrusion of nuclear power station structures as viewed from nearby residential, recreational, scenic, or cultural areas should be controlled by selecting sites where existing topography and forests can be used to screen station structures from those areas in which visual impacts would otherwise be unacceptable.</p>
<b>B.11 Local Fogging and Icing</b>		
<p>Water and water vapor released to the atmosphere from recirculating cooling systems can lead to ground fog and ice, resulting in transportation hazards and damage to electric transmission systems and vegetation.</p>	<p>Increase in number of hours of fogging or icing caused by operation of the station.</p>	<p>The hazards for transportation routes from fog or ice that result from station operation should be evaluated. The evaluation should include estimates of frequency of occurrence of station-induced</p>

Considerations	Parameters	Regulatory Position
		fogging and icing and their impact on transportation, electrical transmission, vegetation, and other activities and functions.
<b>B.12 Cooling Tower Drift</b>		
Concentrations of chemicals, dissolved solids, and suspended solids in cooling tower drift could affect terrestrial biota and result in unacceptable damage to vegetation and other resources.	The percent drift loss from recirculating condenser cooling water, particle size distribution, salt deposition rate, local atmospheric conditions, and loss of sensitive terrestrial biota affected by salt deposition from cooling tower drift.	The potential loss of important terrestrial species and other resources should be considered.
<b>B.13 Cooling Tower Plume Lengths</b>		
Natural draft cooling towers produce cloud-like plumes that vary in size and altitude depending on the atmospheric conditions. The plumes are usually a few miles in length before they dissipate, although plume lengths of 20 to 30 miles have been reported from cooling towers. Visible plumes emitted from cooling towers could cause a hazard to commercial and military aviation in the vicinity of commercial and military airports. The plumes themselves or their shadows could have aesthetic impacts. NUREG-1555, Section 5.3.3.1, discusses procedures for evaluating the frequency of nuclear power plant plumes, as well as hazards to aviation.	The number of hours per year the plume is visible as a function of direction and distance from the cooling towers.	The visibility of cooling tower plumes as a function of direction and distance from cooling towers should be considered. The evaluation should include estimates of frequency of occurrence for plumes, as well as potential hazards to aviation in the vicinity of commercial and military airports.
<b>B.14 Plume Interaction</b>		
Water vapor from cooling tower plumes can interact with industrial emissions from nearby facilities to form noxious or toxic substances that could cause adverse public health impacts, or result in unacceptable levels of damage to biota, structures, and other resources.	The degree to which impacts will occur will vary depending on the distance between the nuclear and fossil-fueled sites, the hours per year of plume interaction, the type and concentration of chemical reaction products, the area of chemical fallout, and the local atmospheric conditions.	The hazards to public health, structures, and other resources from potential plume interaction between cooling tower plumes and plumes from fossil-fueled sites and industrial emissions from nearby facilities should be considered.
<b>B.15 Noise</b>		
Undesirable noise levels at nuclear power stations could occur during both the construction and operation phases and could have unacceptable impacts near the plant.	Applicable Federal, State, and local noise regulations.	Noise levels at proposed sites must comply with statutory requirements.
<b>B.16 Economic Impact of Preemptive Land Use</b>		
Nuclear power stations can preempt large areas, especially when large cooling lakes are constructed. The	The level of local economic dislocation, such as loss of income, jobs, and production, caused by	If a preliminary evaluation of the net local economic impact of the use of productive land for a

<b>Considerations</b>	<b>Parameters</b>	<b>Regulatory Position</b>
<p>land requirement is likely to be an important issue when a proposed site is on productive land (e.g., agricultural land) that is locally limited in availability and is important to the local economy, or which may be needed to meet foreseeable national demands for agricultural products.</p> <p>Under 7 CFR Part 1491, “Farm and Ranch Lands Protection Program,” (Ref. 46) working agricultural lands are protected from conversion to nonagricultural use. Since power reactor sites under consideration are likely to be in rural areas and potentially under cultivation, this regulation could be an applicable parameter for site suitability.</p>	<p>preemptive use of productive land and its effect on meeting foreseeable national demands for agriculture products.</p>	<p>nuclear power station indicates a potential for large economic dislocation, the NRC staff will require a detailed evaluation of the potential impact and justification for the use of the site based on a cost-effectiveness comparison of alternative station designs and site-station combinations. To complete its evaluation, the staff will also need information on whether and to what extent the land use affects national requirements for agricultural products.</p>
<b>B.17 Environmental Justice</b>		
<p>A proposed site may result in significant impacts that will fall disproportionately on minority communities or low-income communities.</p>	<p>Applicable Federal, State, and local and statutory and regulatory requirements.</p> <p>See “Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions” (69 FR 52040) (Ref. 41), for consideration of environmental justice impacts.</p>	<p>Sites that will result in significant impacts that will fall disproportionately on minority communities or low-income communities should be avoided as sites for nuclear power stations.</p>