U.S. NUCLEAR REGULATORY COMMISSION

Revision 2
April 1998

REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 4.7

(Draft was issued as DG–4004)

GENERAL SITE SUITABILITY CRITERIA FOR NUCLEAR POWER STATIONS

A. INTRODUCTION

The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.), as amended, and the Energy Reorganization Act of 1974 places on the Nuclear Regulatory Commission (NRC) the responsibility for the licensing and regulation of private nuclear facilities from the standpoint of public health and safety. Part 100, "Reactor Site Criteria," of Title 10 of the Code of Federal Regulations requires that the population density; use of the site environs, including proximity to man-made hazards; and the physical characteristics of the site, including seismology, meteorology, geology, and hydrology, be taken into account in determining the acceptability of a site for a nuclear power reactor. Seismic and geologic site criteria for nuclear power plants are provided in Appendix A and in 10 CFR 100.23. Appendix A to 10 CFR Part 50 establishes minimum requirements for the principal design criteria for water-cooled nuclear power plants, and Appendix S to Part 50 provides engineering criteria for nuclear power plants. A number 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 Guidelines (40 CFR Parts 1500–1508), requires that all agencies of the Federal Government prepare detailed environmental statements on proposed major Federal actions that can significantly affect the quality of the human environment. A principal objective of NEPA is to require the Federal agency to consider, in its decision-making process, the environmental impacts of each proposed major action and the available alternative actions, including alternative sites.

Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of Title 10 of the Code of Federal Regulations sets forth the NRC's policy and procedures for the 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 the NEPA imposed by the Clean Water Act [Federal Water Pollution Control Act (FWPCA)] (33 U.S.C. 1251 et seq.), as amended, are addressed in the Policy Statement Regarding Implementation of Certain NRC and EPA Responsibilities published in the *Federal Register* on December 31, 1975 (40 FR 60115).

USNRC REGULATORY GUIDES

Regulatory Guides are issued to describe and make available to the public such information as methods acceptable to the NRC staff for implementing specific parts of the Commission's regulations, techniques used by the staff in evaluating specific problems or postulated accidents, and data needed by the NRC staff in its review of applications for permits and licenses. Regulatory guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission.

This guide was issued after consideration of comments received from the public. Comments and suggestions for improvements in these guides are encouraged at all times, and guides will be revised, as appropriate, to accommodate comments and to reflect new information or experience.

Written comments may be submitted to the Rules and Directives Branch, ADM, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001.

The guides are issued in the following ten broad divisions:

1. Power Reactors
2. Research and Test Reactors
3. Fuels and Materials Facilities
4. Environmental and Siting
5. Materials and Plant Protection
6. Products
7. Transportation
8. Occupational Health
9. Antitrust and Financial Review
10. General

Single copies of regulatory guides may be obtained free of charge by writing the Reproduction and Distribution Services Section, Office of the Chief Information Officer, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001; or by fax at (301)415-5272.

Issued guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161.

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 (LWR) nuclear power stations.[1] The guidelines may be used by applicants 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."[2]

Chapter 9 of Regulatory Guide 4.2 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 whose 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 will have to be examined in greater detail before it can be considered to be a "candidate" site, i.e., one of the group of sites that are to be considered in selecting a "proposed" or "preferred" site.[3]

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.

The safety issues discussed include geologic/seismic, hydrologic, and meteorological 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, and socioeconomics.

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. In addition, nuclear power reactor site suitability as it may be affected by the Commission's materials safeguards for nuclear power plants is not addressed in this guide.

A significant commitment of time and resources may be required to select a suitable site for a nuclear power station, 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[4] (including environmental justice) are usually similar to the potential im-

[1]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.

[2]Copies are available for inspection or copying for a fee from the NRC Public Document Room at 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL–6, Washington, DC 20555–0001; telephone (202)634-3273; fax (202)634-3343. Copies of regulatory guides, both active and draft, may be obtained free of charge by writing the Reproduction and Distribution Services Section, OCIO, USNRC, Washington, DC 20555–0001, or by fax at (301)415-5272; or at current rates from the National Technical Information Service by writing NTIS at 5285 Port Royal Road, Springfield, VA 22161.

[3]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.

[4]Biological and physical environment includes geology, geomorphology, surface and groundwater 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.

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

The information collections contained in this regulatory guide are covered by the requirements of 10 CFR Part 50, which were approved by the Office of Management and Budget, approval number 3150–0011. The NRC may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

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[5] (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 have been set forth in 10 CFR Part 100, "Reactor Site Criteria," in Section 100.23, "Geologic and Seismic Siting Criteria" (59 FR 52255). Safety-related site characteristics are identified in Section 2.5 of Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants,"[2] Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion,"[2] and Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants."[2] In addition to geologic and seismic evaluation for assessing seismically induced flooding potential, Section 2.4 of Regulatory Guide 1.70 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[6] and exceptional icing conditions[7]) on the safety-related structures of a nuclear station must be considered. 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 can be designed to withstand most atmospheric extremes.

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.[8] 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.

The atmospheric data necessary for assessment of the potential dispersion of radioactive material are described in Regulatory Guide 1.23, "Onsite Meteorological Programs."[2]

In the evaluation of potential sites, onsite meteorological monitoring can determine if the atmospheric

[5]W.J. Hall, N.M. Newmark, and A.J. Hendron, Jr., "Classification, Engineering Properties and Field Exploration of Soils, Intact Rock and In Situ Rock Masses" (WASH–1301, May 1974), outlines some of the procedures used to evaluate site foundation properties. Copies are available for inspection or copying for a fee from the NRC Public Document Room at 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL–6, Washington, DC 20555–0001; telephone (202)634-3273; fax (202)634-3343.

[6]See Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants."

[7]See Section 2.4.7 of Regulatory Guide 1.70.

[8]Radiation doses associated with routine releases of airborne radioactive material must be kept "as low as is reasonably achievable" (ALARA) [see 10 CFR 20.1101(b)]. 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. Further, 10 CFR 50.36a(a) provides that, in order 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. Appendix I to 10 CFR Part 50 provides numerical guidance for design objectives and technical specification requirements for limiting conditions of operation for light-water-cooled nuclear power plants.

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 may 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 may be required in such cases.

While it is the concentration of radioactive materials in the atmosphere at any distance from the point of release, $\chi(Ci/m^3)$, that must be controlled, the ratio χ/Q, where Q(Ci/sec) is the rate of release of radioactive materials from the source, has become a commonly evaluated term because it depends only on atmospheric variables and distance from the source.

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 in 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 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.

A cooling system designed with special consideration for reducing drift may be required 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 are 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 are often a few miles in length before becoming dissipated, 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) appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway in case of emergency to protect the public health and safety.

In 10 CFR 50.34(a)(1)(ii)(D)(1), the exclusion area is required 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 beyond the exclusion area as a low population zone (LPZ). The size of the LPZ must be such that the distance to the bound-

ary 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 upon consideration of population distribution, not political boundaries.

In 10 CFR 50.34(a)(1)(ii)(D)(2), the LPZ is required to be of such a size that an individual located on its outer radius for 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 upon atmospheric dispersion characteristics and population characteristics of the site as well as aspects of plant design.

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. Part 100 also 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.

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 reducing 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 a significant impediment to the development of emergency plans must be identified."

Additionally, 10 CFR 50.47(a)(1) requires reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency before an operating license for a nuclear power plant can be issued. Adequate plans must be developed for two areas or Emergency Planning Zones (EPZs). As stated in 10 CFR 50.47, the plume exposure pathway EPZ for nuclear power plants generally consists of an area about 16 km (10 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 PLANS

According to 10 CFR 100.21(f), "Site characteristics must be such that adequate security plans and measures can be developed." Physical protection requirements for nuclear power plants as well as special nuclear materials are described in 10 CFR Part 73. Security plans and measures are important to prevent plant damage and possible radiological consequences to members of the public as a result of acts of sabotage.

Based on experience and analysis, the NRC staff has found that a distance of about 110 meters (360 feet) to any vital structure or vital equipment generally would provide sufficient space to satisfy security measures specified in 10 CFR 73.55 (e.g., protected area barriers, detection equipment, isolation zones, vehicle barriers). Since the distance to the nearest exclusion area boundary is considerably greater than 110 meters (360 feet), the site characteristics are not normally limiting with regard to the ability to develop adequate security plans.

A possible exception occurs if the exclusion area is traversed by a highway, railroad, or waterway. Traversal of such routes through the exclusion area is permitted, provided they are not so close that they interfere with normal operations of the facility, and provided appropriate and effective arrangements have been made to control traffic on such routes in case of emergency. If a transportation route passes closer than about 110 meters (360 feet) to a vital structure or vital equipment, special measures or analyses may be needed to show that adequate security plans can be developed.

HYDROLOGY

Flooding

Criteria for evaluation of seismically induced floods are provided in 10 CFR 100.23. Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants,"[2] describes an acceptable method of determin-

ing 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 effects 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 on station safety functions can generally be controlled by engineering design or protection of the safety-related structures, systems, and components identified in Regulatory Guide 1.29, "Seismic Design Classification."[2] For some river valleys, flood plains, or areas along coastlines, there may not be sufficient information to make 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 may be needed to determine the suitability of a site. In lieu of detailed investigations, Regulatory Guide 1.59 and Section 2.4 of Regulatory Guide 1.70 present acceptable analytical techniques for evaluating seismically induced flooding.

Water Availability

Nuclear power stations require reliable sources of water for steam condensation, service water, 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.

Water requirements for nuclear power plants are that sufficient water be available for cooling during plant operation and normal shutdown, for the ultimate heat sink, and for fire protection. 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,"[2] 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). Regulatory agencies should be consulted to avoid potential conflicts.

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 and regional programs and policies is 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 low flow or low-level periods should be determined from the historical record and, if the cooling water is to be drawn from impoundments, from projected operating practices.

Water Quality

Thermal and chemical effluents discharged to navigable streams are governed by the Federal Water Pollution Control Act (FWPCA) (33 U.S.C. 1251 et seq.) (also known as the Clean Water Act) as amended, 40 CFR Part 122, 40 CFR Part 423, and State water quality standards. The applicant should also determine whether there are other regulations that are 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, no construction permit, early site permit, or combined license can be issued by NRC 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.

Evaluations of the 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 are required. Potential radiological and nonradiological contaminants of ground water should be evaluated. 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 only be determined after reliable assessments have been made of the potential

impacts of the reactor on the ground water. Accordingly, 10 CFR Part 100 requires that site environmental parameters, which include hydrological and meteorological characteristics, be characterized and used in or compared to those used in the plant PRA 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 must 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.

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 of Regulatory Guide 1.70). 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 may produce missiles, shock waves, flammable vapor clouds, toxic chemicals, or incendiary fragments. These may 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 may 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 aircraft result from the aircraft itself 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), or (3) the nuclear power station can be designed so its safety will not be affected by the accident.

Potentially hazardous facilities and activities within 5 miles (8 km) of a proposed site, and major airports within 10 miles (16 km) 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)(*1*) should be based on assumptions that are as realistic as is practicable. In addition, because of the low probability events under consideration, 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) to mitigate the consequences of such events have been taken.

The studies described in Section 2.2 of the Standard Review Plan, NUREG–0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants,"[2] should be made 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 evaluation procedures and criteria for potential accidents in the site vicinity.

Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release,"[2] 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,"[2] 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 have an adverse effect on plant operation or prevent a safe shutdown.

Section 3.5.1.6 of the Standard Review Plan (NUREG–0800) describes review procedures regarding potential aircraft hazards.

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.[9] Where the ecological sensitivity of a site under consideration cannot be established from existing information, more detailed studies, as discussed in Regulatory Guide 4.2, may 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 (a) the uniqueness of a habitat or ecological system within the region under consideration and (b) 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

[9]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 criteria applies:

(1) If the species is commercially or recreationally valuable,

(2) If the species is endangered or threatened,

(3) If the species affects the well-being of some important species within criteria (1) or (2) 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." Lists of endangered and threatened species are published periodically in the *Federal Register* by the Secretary of the Interior.

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 man's activities in the proximity to the area, even in the absence of physical disturbance of the actual breeding area.

Of special concern relative to 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 onsite in relation to the total feeding area offsite, food density, time of use, location in relation to other habitats, topography relative to access routes, and other factors (including man's 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 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. The potentials for impingement of organisms on cooling water intake structures and entrainment of organisms through the cooling system are determined by a number of variables, including site characteristics, intake structure design, and placement of the structures at the site.

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

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 can be mitigated by appropriate designs and practices. Aesthetic impacts can be reduced by selecting sites where existing topography and forests can be utilized for screening station structures from nearby scenic, historical, or recreational resources. Restoration of natural vegetation, creative landscaping,[10] and the integration of structures with the environment can mitigate adverse visual impacts.

Preconstruction archeological excavations can usually reduce losses. Short-term salvage archeology may not be sufficient if extensive or valuable archeological sites are found on the potential site for a nuclear station. 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 Liaison Officer, or both, responsible for the National Historic Preservation Act activities for a particular State, Reservation, or both.

Proposed alternative land use may render a site unsuitable for a nuclear power station. For example, lands specified by a community (1) as planned for other uses or (2) as restricted to compatible uses vis-a-vis other lands may be unsuitable. 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. A list of Federal agencies that have jurisdiction or expertise in land use

[10]Station protection requirements for nuclear safeguards may influence landscape design and clearing of vegetation.

planning, regulation, or management has been published by the Council on Environmental Quality.[11]

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.

Sites adjacent to lands devoted to public use may 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 may cause unacceptable impacts regardless of design parameters. Such cases are most apt to arise in areas adjacent to natural-resource-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 may 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 Federal agencies 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 may 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.

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 may have significant impacts on the socioeconomic structure of a community and may place severe stresses on the local labor supply, transportation facilities, and community services in general. There may be changes in the tax basis and in community expenditures, and problems may 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 impacted communities; however, some impacts may 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 may 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

[11] 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.

places of historic interest, have specialized in an unusual industry or avocational activity, or have otherwise markedly distinguished themselves from other communities.

Siting decisions should reflect fair treatment and meaningful involvement of all people, regardless of race, ethnicity, culture, income or educational level to assure equitable consideration and to minimize disproportionate effects on minority and low-income populations.[12]

NOISE

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

C. REGULATORY POSITION

1. GEOLOGY AND SEISMOLOGY

Preferred sites are those with a minimal likelihood of surface or near-surface deformation and a minimal likelihood of earthquakes on faults in the site vicinity (within a radius of 8 km (5 miles)). 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 data base is inadequate to determine their potential for causing surface deformation, are likely to be subject to a longer licensing process in view of the need for extensive and detailed geologic and seismic investigations of the site and surrounding region and for the 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 may also provide satisfactory foundation conditions, but a detailed geologic and geotechnical investigation would be required 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

As noted in the Discussion Section of this guide, 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 meteorological information for at least one year that is representative of the site conditions, including wind speed, 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. The atmospheric data necessary for the assessment of nonradiological considerations are described in Regulatory Guide 1.23, "Onsite Meteorological Programs."[2]

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 the 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 total effective dose equivalent (TEDE) over any two-hour period following a postulated fission product release into the containment.

An applicant is also required by 10 CFR Part 100 to designate an area immediately beyond the exclusion area as a low population zone (LPZ). The size of the LPZ must be such that the distance to the nearest

[12]The NRC committed to carry out the measures set forth in Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (59 FR 7629), to consider the effects of its actions on minority and low-income communities.

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 upon consideration of 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 (assumed to be 30 days) would not receive a radiation dose in excess of 25 rem TEDE.

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 reducing 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.

Preferably a reactor would be located so 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 circular area at that distance), does not exceed 500 persons per square mile. A reactor should not be located at a site whose population density is well in excess of the above 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 having lower population density. However, consideration will be given to other factors such as safety, environmental, or economic considerations, which 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 upon undeveloped areas, wetlands, or endangered species.

The transient population should be included for those sites where a significant number of people (other than those just passing through the area) work, reside part-time, or engage in recreational activities and are not permanent residents of the area. The transient population should be taken into account for site evaluation purposes by weighting the transient population according to the fraction of time the transients are in the area.

Projected changes in population within about 5 years after initial site approval should be evaluated for the proposed site and any alternative sites considered. Population growth in the site vicinity after initial site approval is normal and expected and will be periodically factored into the emergency plan for the site, but population increases after initial site approval will 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."

An examination and evaluation of the site and its vicinity, including the population distribution and transportation routes, should be conducted to determine whether there are any characteristics that would pose a significant impediment to taking protective actions to protect the public in the event of emergency.

Special population groups, such as those in hospitals, prisons, or other facilities that could require 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) should be performed to estimate the time periods that would be required to evacuate various sectors of the plume exposure emergency planning zone (EPZ), including the en-

tire 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. Information on performing an ETE analysis is given in Appendix 4 to NUREG–0654/FEMA–REP–1, Revision 1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants" (November 1980).[2] The value of the ETE analysis is in the methodology required to perform the analysis rather than in the calculated ETE times. While lower ETEs may reflect favorable site characteristics from an emergency planning standpoint, there is no minimum required evacuation time in the regulations that an applicant has to meet.

6. SECURITY PLANS

According to 10 CFR 100.21(f), "Site characteristics must be such that adequate security plans and measures can be developed." Also, 10 CFR Part 73 describes physical protection requirements for nuclear power plants as well as special nuclear materials.

Generally, a distance of about 110 meters (360 feet) to any vital structure or vital equipment would provide sufficient space to satisfy security measures of 10 CFR 73.55 (e.g., protected area barriers, detection equipment, isolation zones, vehicle barriers). If the distance to a vital structure or vital equipment is less than about 110 meters (360 feet), special measures or analyses may be needed to show that adequate security plans can be developed.

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 1.59, "Design Basis Floods for Nuclear Power Plants,"[2] should be made.

7.2 Water Availability

A highly dependable system of water supply sources must be shown to be available under 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 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 can be obtained by the applicant from the appropriate State, local, or regional agency.

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 Federal Water Pollution Control Act are applicable and satisfied.

The criteria in 10 CFR Parts 20 and 50 will be used by the NRC staff for determining permissible concentrations of radioactive materials discharged to surface water or to ground water.[13]

7.4 Fission Product Retention and Transport

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

- Soil, sediment, and rock characteristics (e.g., volcanic ash, fractured limestone),
- Absorption and retention coefficients for radioactive materials,
- Ground-water velocity, and
- Distance to nearest body of surface water.

This information should be used in the environmental report required in 10 CFR Part 51 and compared to the hydrological information used in the PRA or other analyses for a certified plant design (if such a design is to be located at the site) or used in the site-specific PRA for a custom plant located at the site.

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 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants,"[2] should be completed.

8. INDUSTRIAL, MILITARY, AND TRANSPORTATION FACILITIES

According to 10 CFR 100.21(e), "Potential hazards associated with nearby transportation routes, in-

[13] Appendix I to 10 CFR Part 50 provides numerical guidance for design objectives and technical specification requirements for limiting conditions of operation for light-water-cooled nuclear power stations.

dustrial 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), or (3) the nuclear power station can be designed so its safety will not be affected by the accident.

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. The design basis tornado is described in Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants."[2]

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 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 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 is practicable. Because of the low-probability events under consideration, 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) to mitigate the consequences of such events have been taken.

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 there would be no unacceptable or unnecessary deleterious impacts on populations of important species or on ecological systems with which they are associated from the construction or operation of a nuclear power station at the site.

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 to-

tal estimated population over the entire range of the species as noted in the literature.

It should be determined whether there are any important ecological systems at a site or in its environs. If so, 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 may impact on important ecological systems or habitats that are unique, limited in extent, or necessary to the productivity of populations of important species (e.g., wetlands and estuaries), 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.

A summary of environmental considerations, parameters, and regulatory positions for use in evaluating sites for nuclear power stations is provided in Appendix B to this guide.

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 provided 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 of concern, and evaluation of such sites is dependent on consideration of specific station design layout.

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.

12. NOISE

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

D. IMPLEMENTATION

The purpose of this section is to provide guidance to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with the specified portions of the NRC's regulations, the methods in this active guide will be used in the evaluation of applications for construction permits, early site permits, operating licenses, combined licenses, or design certification. This guide would not be used in the evaluation of an application for an operating license submitted after January 10, 1997, if the construction permit was issued prior to that date.

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
A.1 Geology/Seismology		
Geologic and seismic characteristics of a site, such as surface faulting, ground motion, and foundation conditions (including liquefaction, subsidence, and landslide potential), may affect the safety of a nuclear power station.	10 CFR 100.23, "Geologic and Seismic Siting Factors" Regulatory Guide 1.70, Chapter 2 (identifies safety-related site characteristics)[1] Regulatory Guide 1.29 (discusses plant safety features which should be controlled by engineering design)[1] Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion"[1] Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants"[1]	Where the potential for permanent ground deformation such as faulting, folding, subsidence, or collapse exists at a site, the NRC staff considers it prudent to select an alternative site. Sites should be selected in areas for which an adequate geologic data base exists or can be expeditiously developed through site-specific investigations to identify and characterize potential geological and seismic hazards. Delay in licensing can result from a need for extensive geologic and seismic investigations. Conservative design of safety-related structures will be required when geologic, seismic, and foundation information is questionable. Sites with competent bedrock generally have suitable foundation conditions. If bedrock sites are not available, it is prudent to select sites in areas known to have a low subsidence and liquefaction potential. Investigations will be required to determine the static and dynamic engineering properties of the material underlying the site as stated in Appendix A to 10 CFR Part 100 and 10 CFR 100.23.

[1]Copies are available for inspection or copying for a fee from the NRC Public Document Room at 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL–6, Washington, DC 20555–0001; telephone (202)634-3273; fax (202)634-3343. Requests for single copies of regulatory guides should be made in writing to the U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, Attn: Reproduction and Distribution Services Section, or by fax to (301)415–5272; or guides may be purchased from the National Technical Information Service by writing NTIS at 5285 Port Royal Road, Springfield, VA 22161.

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
A.2 Atmospheric Dispersion		
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.	10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities" Regulatory Guide 1.23, "Onsite Meteorological Programs"[1] Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants"[1] Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors"[1] Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors"[1] Regulatory Guide 1.5, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Steam Line Break Accident for Boiling Water Reactors"[1] 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"[1]	Unfavorable safety-related design basis atmospheric dispersion characteristics can be compensated for by engineered safety features. Accordingly, the regulatory position on atmospheric dispersion of radiological effluents is incorporated into the section "Exclusion Area and Low Population Zone" (see A.3 of this appendix).

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
A.3 Exclusion Area and Low Population Zone		
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.	• 10 CFR Part 100, "Reactor Site Criteria," 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. • 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," 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 specified time periods. • Regulatory Guides 1.3, 1.4, 1.5, and 1.25 give calculational methods (see A.2 of this appendix.)	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 upon plant design aspects such as the reactor power level, allowable containment leak rate, and those engineered safety features incorporated into the design, as well as the atmospheric dispersion characteristics of the site.

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
A.4 Population Considerations		
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 reducing potential doses and property damage in the event of a severe accident.	10 CFR Part 100, "Reactor Site Criteria," requires the following: • 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 nearest distance to the boundary of a 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. • 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.	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 whose population density is well in excess of the above value. If the population density of the 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 having lower population density. Consideration will be given to other factors, such as safety, environmental, or economic, which may result in the site with higher population density being found acceptable. Transient population should be included for those sites where a significant number of people (other than those just passing through the area) work, reside part-time, or engage in recreational activities, and are not permanent residents of the area. The transient population should be taken into account by weighing the transient population according to the fraction of time the transients are in the area.

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
A.5 Emergency Planning		
To ensure that adequate protective measures can be taken to protect members of the public in the event of an emergency, the characteristics of the site should not preclude development of such plans.	10 CFR Part 100, "Reactor Site Criteria," requires that: • Site characteristics must be such that adequate plans to take protective actions for members of the public in the event of emergency can be developed. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires: • Reasonable assurance that adequate protection can and will be taken in the event of a radiological emergency. • Emergency planning zones (EPZ) consisting of the plume exposure pathway EPZ with an area about 16 km (10 mi) in radius, and the ingestion pathway EPZ with an area about 80 km (50 mi) in radius. 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" (November 1980),[2] provides guidance on performing an ETE.	An examination and evaluation of the site should be conducted to determine whether there are any characteristics that would pose a significant impediment to taking protective actions to protect the public in the event of emergency. 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. Special population groups, such as those in hospitals, prisons, or other facilities that could require special needs during an emergency, should be identified. An evacuation time estimate (ETE) should be performed to estimate the time periods that would be required to evacuate various sectors of the plume exposure emergency planning zone (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 an applicant must meet.

[2]Copies are available at current rates from the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20402–9328 (telephone (202)512–2249); or from the National Technical Information Service by writing NTIS at 5285 Port Royal Road, Springfield, VA 22161. Copies are available for inspection or copying for a fee from the NRC Public Document Room at 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL–6, Washington, DC 20555; telephone (202)634–3273; fax (202)634–3343.

Considerations	Relevant Regulations and Regulatory Guides	Regulaory Experience and Position
A.6 Security Plans		
To prevent plant damage, and possible radiological consequences to the public as a result of acts of sabotage, the characteristics of the site should not preclude development of adequate security plans.	10 CFR 100.21(f) states that site characteristics must be such that adequate security plans and measures can be developed. Also, 10 CFR Part 73, "Physical Protection of Plants and Materials," prescribes requirements for establishment and maintenance of a physical protection system for the protection of special nuclear materials at fixed sites and of plants in which special nuclear material is used.	Generally, a distance of about 110 meters to any vital structure or vital equipment would provide space sufficient to satisfy security measures specified in 10 CFR 73.55 (e.g., protected area barriers, detection equipment, isolation zones, vehicle barriers). If the distance to a vital structure or vital equipment is less than about 110 meters, special measures or analyses may be required to show that adequate security plans can be developed.
A.7 Hydrology		
A.7.1 Flooding		
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.	10 CFR 100.23, "Geologic and Seismic Siting Criteria" Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants"[1] Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants" (Section 2.4)[1] 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants;" Criterion 2, "Design Bases for Protection Against Natural Phenomena"	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 made.

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
A.7.2 Water Availability		
A safety-related water supply is required for normal or emergency shutdown and cooldown.	10 CFR 100.23, "Geologic and Seismic Siting Criteria" Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants"[1] Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants"[1]	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. To evaluate the suitability of a site, there must a reasonable assurance that 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 can be obtained by the applicant from the appropriate State, local, or regional agency.
A.7.3 Water Quality		
Contamination of ground water and surface water by radioactive materials discharged from nuclear stations could cause public health hazards.	10 CFR Part 20, "Standards for Protection Against Radiation" 10 CFR Part 50, "Licensing of Production and Utilization Facilities"	The criteria provided in 10 CFR Parts 20 and 50 will be used by the NRC staff for determining permissible concentrations of radionuclides discharged to surface water and ground water.

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
A.8 Industrial, Military, and Transportation Facilities		
Accidents at present or projected nearby industrial, military, and transportation facilities may affect the safety of the nuclear power station.	10 CFR 100.21, "Non-seismic Siting Criteria" 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," Criterion 4, "Environmental and Dynamic Effects Design Bases" Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Section 2.2[1] (lists types of facilities and potential accidents) Regulatory Guide 1.78, "Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release"[1]	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 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. The acceptability of a site depends upon establishing that (1) an accident at a nearby facility or route will not result in radiological consequences that exceed the dose set forth in 10 CFR 50.34, or (2) the accident is sufficiently unlikely to occur that it poses no undue risk, or (3) the nuclear power station can be designed so its safety will not be affected by the accident. The identification of design basis events resulting from the presence of nearby 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 a potential dose in excess of that set forth in 10 CFR 50.34 exceeds approximately 10^{-7} per year.

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 of 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 taken into account, such limits can be useful in a screening process for site selection.

Considerations	Parameters	Regulatory Position
B.1 Preservation of Important Habitats		
Important habitats are those that are essential to maintaining the reproductive capacity and vitality of important species populations (defined in the Discussion section 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. 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.	The proportion of an important habitat that would be destroyed or significantly altered in relation to the total habitat within the region in which 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. The value of the proportion varies among species and among habitats. The region considered in determining proportions is the normal geographic range of the specific population in question. 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. See also Chapter 2 of Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Stations."[1]	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. The reproductive capacity of populations of important species and the harvestable crop of economically or recreationally important populations must be maintained unless justification for proposed or probable changes can be provided.

[1]Copies are available for inspection or copying for a fee from the NRC Public Document Room at 2120 L Street NW., Washington, DC; the PDR's mailing address is Mail Stop LL–6, Washington, DC 20555–0001; telephone (202)634-3273; fax (202)634-3343. Requests for single copies of regulatory guides should be made in writing to the U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001, Attn: Reproduction and Distribution Services Section, or by fax to (301)415–5272; or guides may be purchased from the National Technical Information Service by writing NTIS at 5285 Port Royal Road, Springfield, VA 22161.

Considerations	Parameters	Regulatory Position
B.2 Migratory Routes of Important Species		
Seasonal or daily migrations are essential to maintaining the reproductive capacity of some important species populations. 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).	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 1/3 to 3/4 of the width or cross-sectional areas of narrow water bodies.[2,3] 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 a knowledge of important species and their migratory requirements.	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.

[2]*Water Quality Criteria*, National Academy of Sciences—National Academy of Engineering, Washington, DC, 1972.

[3]*Handbook of Environmental Control, Volume III: Water Supply and Treatment,* R.G. Bond and C.P. Straub (Editors), CRS Press, Cleveland, Ohio, 1973.

Considerations	Parameters	Regulatory Position
B.3 Entrainment and Impingement of Aquatic Organisms		
Plankton, including eggs, larvae, and juvenile fish, can be killed or injured by entrainment through power station cooling systems or in discharge plumes. 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. Fish and other aquatic organisms can be killed or injured by impingement on cooling water intake screens[4] or by entrainment in discharge plumes.	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. 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% of flow.[5,6] 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 the advice of experts on the local fisheries should be consulted to ensure that proposed withdrawals will not be excessive.	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.) Important habitats (see B.1 of this Appendix B) should be avoided as locations for intake structures.
B.4 Entrapment of Aquatic Organisms		
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. Entrapment can also interrupt normal migratory patterns.	Site characteristics that will accommodate design features that mitigate or prevent entrapment.	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.

[4]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.

[5]*The Water's Edge: Critical Problems of the Coastal Zone,* B.H. Ketchum (Editor), MIT Press, Cambridge, Mass., 1972.

[6]"Engineering for Resolution of the Energy-Environment Dilemma," National Academy of Engineering, Washington, DC, 1972.

Considerations	Parameters	Regulatory Position
B.5 Water Quality		
Effluents discharged from nuclear power plants are governed under the authority of the Federal Water Pollution Control Act (FWPCA)— (PL 92–500).	Applicable EPA-approved State water quality standards. For states without EPA-approved water quality standards, the water quality criteria listed in *Water Quality Criteria*, 1972,[2] will be used for evaluation.	Pursuant to Section 401(a)(1) of the FWPCA, 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. Issuance of a permit pursuant to Section 402 of the Act is not a prerequisite to an NRC license or permit. 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.
B.6 Water Availability		
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.	Applicable Federal, State, and local statutory requirements. Compatability with water use plan of cognizant water resource planning agency. 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, Water Quality, of this appendix).	Water use and consumption must comply with statutory requirements and be compatible with water use plans of cognizant water resources planning agencies. Consumptive use should be restricted such that the supply of other users is not impaired and that applicable surface water quality standards could be met, assuming normal station operational discharges and extreme low flow conditions defined by generally accepted engineering practices. 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, Preservation of Important Habitats, of this appendix) or be inconsistent with the management goals for the water body.

Considerations	Parameters	Regulatory Position
B.7 Established Public Amenity Areas		
Areas dedicated by Federal, State, or local governments to scenic, recreational, or cultural purposes are generally prohibited areas for siting power stations. Siting nuclear power stations in the vicinity of established public amenity areas could result in the loss or deterioration of important public amenities.	Proximity to public amenity area. Viewability (see B.10, Visual Amenities, of this appendix).	Siting in the vicinity of designated public amenity areas will generally require extensive evaluation and justification. The evaluation of the suitability of sites in the vicinity of public amenity areas is dependent on consideration of a specific plant design and station layout in relation to potential impacts on the public amenity area.
B.8 Prospective Designated Amenity Areas		
Areas containing important resources for scenic, recreational, or cultural use may not currently be designated as such by public agencies but may 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.	Comparison of possible amenity areas in number and extent with other similar areas available on a local, regional, or national basis, as appropriate.	Public amenity areas that are distinctive, unique, or rare in a region should be avoided as sites for nuclear power stations.
B.9 Public Planning		
Land use for a nuclear power station should be compatible with established land use or zoning plans of governmental agencies.	Officially adopted land use plans.	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.
B.10 Visual Amenities		
The presence of power station structures may introduce adverse visual impacts to residential, recreational, scenic, or cultural areas or other areas with significant dependence on desirable viewing characteristics.	The solid angle subtended by station structures at critical viewing points.	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 utilized for screening station structures from those areas in which visual impacts would otherwise be unacceptable.

Considerations	Parameters	Regulatory Position
B.11 Local Fogging and Icing		
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.	Increase in number of hours of fogging or icing caused by operation of the station.	The hazards on 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 fogging and icing and their impact on transportation, electrical transmission, and other activities and functions.
B.12 Cooling Tower Drift		
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.13 Cooling Tower Plume Lengths		
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 becoming dissipated, 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.	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.14 Plume Interaction		
Water vapor from cooling tower plumes may 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 may 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.

Considerations	Parameters	Regulatory Position
B.15 Noise		
Undesirable noise levels at nuclear power stations could occur during both the construction and operation phases and have unacceptable impacts near the plant.	Applicable Federal, State, and local noise regulations.	Noise levels at proposed sites must comply with statutory requirements.
B.16 Economic Impact of Preemptive Land Use		
Nuclear power stations can preempt large areas, especially when large cooling lakes are constructed. The 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.	The level of local economic dislocation, such as loss of income, jobs, and production, caused by preemptive use of productive land and its effect on meeting foreseeable national demands for agriculture products.	If a preliminary evaluation of net local economic impact of the use of productive land for a 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.
B.17 Environmental Justice		
A proposed site could have inequitable impacts on minority and low-income communities.	Applicable Federal, State, and local statutory and regulatory requirements.	Areas that disproportionately affect minority or low-income populations should be avoided as sites for nuclear power stations.

DRAFT REGULATORY ANALYSIS

A separate regulatory analysis was not prepared for this guide. The regulatory analysis prepared for the amendments to 10 CFR Parts 50 and 100 provides the regulatory basis for this guide and examines the costs and benefits of the rulemaking as implemented by the guide. A copy of the regulatory analysis is available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street NW., (Lower Level), Washington, DC, with the file on the amendments to 10 CFR Parts 50 and 100.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

FIRST CLASS MAIL
POSTAGE AND FEES PAID
USNRC
PERMIT NO. G-67