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PROCEDURE

FOR

SITE HAZARDS EVALUATION AND IMPACT ASSESSMENT

Revision 1

September 2009

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REVISION HISTORY RECORD OF CHANGES

Revision No.	Revision Made By	Description	Date
0	George Zinke Entergy Nuclear	Initial Issue	8/31/2009
1	George Zinke Entergy Nuclear	Incorporated comments in Executive Summary, misc editorial corrections	9/8/2009

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EXECUTIVE SUMMARY

This task consisted of developing a guidance document for the assessment of external hazards and other environmental characteristics or constraints and their impact on deployment of Next Generation Nuclear Plant (NGNP) reactor technology. This procedure and associated generic templates define a process to be applied at representative sites in order to identify potential hazards or other challenges/restraints that would need to be addressed as a part of the design and licensing processes in order to assure that NGNP can ultimately be deployed at a variety of sites for its intended range of applications. This document provides a methodology for evaluating key characteristics for a potential site to determine site suitability for installation of a NGNP reactor technology.

The procedure provides guidance for evaluating three types of sites: (1) existing nuclear facility sites; (2) "brownfield" sites where existing industrial facilities are located, or where industrial facilities have been operated; and, (3) "greenfield" sites where no facilities are presently located. The procedure groups the key characteristics by regulatory considerations (i.e., Health and Safety, Environmental, Sociological) and other considerations (i.e., Land Availability, Constructability and Contamination Hazards) and describes each characteristic and group of characteristics in terms of importance and risk. The "requirements" referenced in the templates are based on existing light water reactor regulations and guidance. Therefore, evaluators using these templates are directed by this procedure to use judgment in the application of the referenced regulations and guidance documents. The procedure specifies that for each site characteristic evaluated a judgment is to be made as to the acceptability of the site for a NGNP reactor with respect to that characteristic. Sites will be classified as "Acceptable Site," "Challenged Site Requiring Further Evaluation" or "Site Not Suitable." For each assessment performed using this procedure, the results of the site hazards evaluations are to be compiled into a final report that provides an overall conclusion with regard to suitability of the site for a NGNP reactor with respect to the hazards considered.

Since the gas reactor designs are still in the conceptual design phase some design parameters included in the templates may not be known at the time of the feasibility assessment. To address this eventuality, the procedure also provides a mechanism to gather and analyze site data related to these parameters so that this information may be used to further develop the NGNP design.

It is expected that following the performance of the initial site assessments using this procedure, lessons learned will be identified that result in revisions and improvements to the procedure. Additionally, as more insight is achieved through interaction with the NRC staff regarding which light water reactor requirements and guidance documents are applicable or not applicable to gas reactors, updates to the evaluation criteria will be made.

The procedure was prepared and reviewed by Entergy Nuclear Inc. (Entergy) and ENERCON Services, Inc., under the direction of Entergy.

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1.0 Introduction

This procedure provides a methodology that can be employed for the purpose of evaluating and assessing key characteristics of a potential site, and determining site suitability for installation of a next generation nuclear plant reactor technology. Potential sites may be any of three types (i.e., “Greenfield” site, “Brownfield” site or existing nuclear power plant site).

The procedure groups the key characteristics by regulatory considerations (i.e., Health and Safety, Environmental, Sociological) and other considerations (i.e., Land Availability, Constructability and Contamination Hazards) and describes each characteristic and group of characteristics in terms of importance and risk. The procedure also describes recommended methodologies to employ when evaluating each characteristic for site suitability.

A template is provided for each characteristic (or group of characteristics, where appropriate), which should be used as a guide when conducting the site feasibility review for that site characteristic (or group of characteristics, as appropriate). The templates contain important information relative to the characteristic being evaluated, as well as evaluation methodology recommendations. The characteristic templates are listed and further discussed in Section 4.0 of this procedure.

This procedure has been developed after review of several other siting guides and/or studies, as well as regulatory guidance, as noted in the References (Section 7.0). However, the procedure is not intended to replace or to be used as an alternative to applicable regulatory requirements or guidance.

2.0 Purpose and Scope

The purpose of this procedure is to provide instructions for performing a site hazards and impact assessment with the intent of completing an initial screening of candidate sites. This screening will assess the suitability of a site with respect to key site characteristics, and is expected to provide key insights that can inform the plant design process as it proceeds. The assessment will examine the site for potential hazards to suitability and will describe actions necessary to mitigate the impacts of those hazards. Key site characteristics will be assessed individually, and the site will be classified as acceptable, challenged or not suitable with respect to each characteristic. This process should provide a supportable basis for determining that a site is not acceptable and should receive no further consideration. It also will identify the risks and potential cost adders associated with the site that need to be evaluated further. A site that remains a candidate after this initial screening will be subject to additional evaluation as part of a more-detailed site investigation process.

It is expected that, by following the applicable site characteristic-specific templates, along with any additional information in the corresponding sections of the procedure, an evaluator will be able to evaluate and grade the specific technical area (characteristic) being reviewed. Possible classifications of the site, based on each specific characteristic evaluation, include “acceptable site”, “potential challenged site requiring further evaluation”, or “site not suitable.”

This procedure provides a set of templates for conducting a site feasibility assessment for a variety of types of potential sites and site characteristics requirements. The site types are defined and discussed in Section 3.1. The site characteristics requirements

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are discussed in Section 3.2 and are listed in Appendices A and B. The templates are listed in Section 4.0 of the procedure and are contained in Appendix C. Addenda to selected templates are in Appendix D.

3.0 Site Types and Site Characteristics Requirements

Three types of potential sites are candidates for evaluation using this procedure: (1) existing nuclear power plant sites, (2) "Brownfield" sites, where existing industrial facilities (or their remains) are located, and (3) "Greenfield" sites, where no facilities (or their remains) are present. These site types are further discussed below.

3.1 Site Types

3.1.1 Existing Nuclear Power Plant Sites

Existing NPP sites have the advantage of previous analyses of most, if not all, of the site characteristics of interest, and the characteristic evaluations may be facilitated by those previous analyses.

3.1.2 Brownfield Sites

A Brownfield site is defined as "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant." Brownfield sites comprise commercial or industrial sites, including those which are now abandoned or sparingly utilized, including legacy nuclear sites (e.g., a DOE site where nuclear materials may have been handled or processed). Brownfield sites have the arguable advantage of prior development, potentially easing land use issues, but they might be subject to prior pollution or the presence of asbestos or some other environmental contaminant. Previous site evaluation information may, or may not, be available, depending on prior site use.

3.1.3 Greenfield Sites

Greenfield sites comprise areas beyond urban areas, such as agricultural or forest land, or other land not previously developed or polluted, where development can take place unfettered by earlier building. Greenfield sites have the advantage of a low likelihood of industrial pollution, but there may be little site-specific data with which to conduct characteristic evaluations. Development of a Greenfield site may involve greater environmental impacts than for an existing nuclear plant site or a Brownfield site.

3.2 Site Characteristic Requirements Information

Site characteristic requirements may differ, depending on the reactor technology type. Appendix A lists and defines the key technology design parameters that the site must accommodate in order to use the corresponding reactor technology. Appendices A and B list expected parameters for a nuclear reactor technology. Values were not available at the time of this procedure development and will need to be obtained from the reactor vendors of interest. The parameters listed support safety, environmental, and or commercial evaluations. Not all of the parameters are needed for license applications.

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Since the reactor designs are still in the conceptual design phase it should be noted that some design parameters may not be known at the time of the feasibility assessment. In those cases the evaluator is expected to characterize the design features of the site related to the parameter. The evaluator will be unable to draw any conclusions regarding site acceptability.

4.0 Site Characteristic Evaluation Templates

Templates are provided in Appendix C to assess each key site characteristic in the following categories: Health and Safety, Environmental, and Sociological Impacts and Other Siting Considerations. Each characteristic is evaluated with a separate template, and each template identifies the following information:

- description of characteristic being evaluated.
- discussion of the importance of the site characteristic.
- criteria that must be satisfied in order for the site to be assessed as an acceptable site, challenged site, or site not suitable.
- site type (See Section 3.1).
- reactor technology (See Section 3.2).
- discussion of the risks associated with not satisfying the associated criteria.
- risk mitigation recommendations, if any.
- regulatory references.

Sections 4.1 and 4.2 identify the site characteristics to be evaluated for the candidate site and reactor technology. Each characteristic should be evaluated using the applicable template in Appendix C, and a judgment should be made, based on that evaluation, as to the suitability of the specific site type and applicable site characteristic requirements. The evaluation process is described in Section 5. It is important to note that the “requirements” have been based on existing light water reactor regulations and guidance. For example, Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants”, is written exclusively for Light Water Reactors, but contains information generally applicable to other types of reactors. NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants”, is not exclusive to Light Water Reactors; however it is heavily based on 10 CFR 50 Appendix A (General Design Criteria) which contains minimum requirements for water cooled reactors, but is only intended to provide guidance in establishing the principal design criteria for other types of nuclear power units. Therefore, the evaluator will be required to use judgment in application of the regulations and guidance documents, pending available design and configuration information, and NGNP-applicable regulations and guidance documents.

New or additional federal, state, or local requirements or regulations, requirements unique to the site location, new regulations for advanced reactor technologies, new or revised regulatory guidance for advanced reactor technologies, or other project limitations could require the templates to be revised.

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4.1 Regulatory and Technology Site Characteristic Templates

Regulatory site characteristic templates are categorized and listed in this section as follows: Health and Safety, Environmental and Sociological Impacts. Each category is progressively subdivided into sub-categories until arriving at a site characteristic that must be evaluated. The methodology for evaluation of the characteristic is discussed in the associated template of Appendix C.

4.1.1 Health and Safety Characteristic Templates

Health and safety characteristic templates include: site geotechnical properties such as shear wave velocity and bearing capacity; susceptibility of the site to potential deformation through presence of local capable faults, subsidence, or landslides; availability of sufficient water to support plant operations; susceptibility of the site to flooding issues that could adversely affect plant safety; existence of land use hazards near the site that could adversely affect the safety of the plant; extreme weather issues; radiological considerations; population considerations, security and emergency planning issues that could challenge development of adequate emergency plans to support the safety and health of the public, as listed below.

- Geology, Seismology and Geotechnical Engineering
 - Seismic Ground Motions
 - Global Geohazards
 - Site Geotechnical
- Hydrology
 - Water Availability
 - Flooding
- Nearby Hazardous Activities/Facilities that Could Affect Plant Safety
- Extreme Weather Considerations
- Radiological Considerations
 - Atmospheric Dispersion – Accident Conditions
- Emergency Planning
- Population

4.1.2 Environmental Characteristic Templates

Environmental characteristic templates include: ecology, including the potential for presence of threatened and endangered species, and the presence of wetlands or other fragile habitats; land use; water use; archeological/cultural resource issues, as listed below.

- Ecology
 - Terrestrial

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- Aquatic
- Land Use
 - Transmission Corridors and Transportation Routes
 - Historic/ Archeological/Cultural Resource Issues
- Water Use

4.1.3 Sociological Impact Characteristic Templates

Sociological impacts include public acceptance, environmental justice issues, and socioeconomic impacts on the community, as listed below.

- Public Acceptance
- Aesthetics
- Environmental Justice Considerations
- Socioeconomic Effects

4.2 Other Site Characteristic Templates

Other site characteristics address land availability/cost, site constructability factors and site decontamination potential, as listed below.

- Land Availability
- Site Constructability Factors
- Potential for Brownfield Contamination Issues
- Features that Could Affect Development of Security Measures and Adequate Security Plans
- Sample Template (with instructions)

The sample template is provided in case either the reactor technology or the customer's requirements contains unique parameters which are not enveloped by the existing templates

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5.0 Evaluation Process

5.1 Typical Evaluation Process

The first step in the evaluation process is to determine the project, customer, and site owner goals and limitations. Potential goals and limitations could include: desired reactor technology, desired outputs of the plant (e.g. electricity, steam, process heat, etc.), limitations on plant physical location, non-nuclear regulations/agreements applicable to site, emergency preparedness goals, etc. This information should be documented in the final report and factored into individual templates as applicable. The plant design assumptions of the customer should agree with the design parameters gathered in the second step of the evaluation process.

The second step in the evaluation process is to complete the Appendix B Design Parameter Worksheet(s) using information obtained from the reactor vendors for the technologies to be considered for a site. This information is reactor specific design parameter information that will provide the bounding values used in the evaluations documented in the Site Characteristic Evaluation Templates located in Appendix C. [NOTE: If design parameters (bounding or actual) are not available, Section 5.2 below provides additional instructions.]

Once Design Parameter Worksheets are complete, the evaluator should identify and review the template associated with the characteristic being evaluated. The information, references, and methods described on each template assist the evaluator in assessing the corresponding site characteristic and establishing the evaluation results (i.e., Acceptable Site, Challenged Site Requiring Further Evaluation, or Site Not Suitable). It is important to note that the "requirements" in the templates have been based on existing light water reactor regulations. New, revised, or additional federal, state, or local requirements or regulations, requirements unique to the site location, new regulations for advanced reactor technologies, or other project limitations could require the templates to be revised. In this case, subject matter experts in the fields associated with the template in question should review current regulations, regulatory guidance, applicable standards, design parameters, and project or customer limitations and revise accordingly. If new site characteristics are identified that require evaluation, a sample template form with instructions is provided in Appendix C. The primary goal of the evaluation templates is to provide the framework on which the hazards analysis and impact assessment for each prospective site can be built. In general, the evaluator should be aware of and familiar with the guidance and requirements in RG 1.206, RG 4.2, RG 4.7, EPRI Siting Guide, NUREG-0800, and NUREG-1555.

Normally, it should be possible to apply the templates by utilizing available information and without the need for new analyses or field work. For example, lab/computer analyses are not anticipated in the initial assessment unless there is reason to believe that there is a high risk that the site characteristic is problematic, in which case, analysis might be cost-justified for the initial assessment. Potential situations like this are described in the individual site characteristic assessment template. The templates are not intended to limit the

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evaluator to certain evaluation methods or data. However, evaluations should not be inconsistent with applicable regulatory guidance. Qualitative judgments should be adequately documented and supported, and consideration should be given to the applicability of 10 CFR 50 Appendix B requirements if it is possible that template evaluations may be relied upon for determinations involving future safety-related activities (see Section 6).

After the site characteristic is evaluated, a judgment will be made, based on that evaluation, as to the acceptability of the site for the selected reactor technology(ies) with respect to that characteristic, and hazards and risks to site acceptability should be identified. Sites will be classified as “Acceptable Site,” “Challenged Site Requiring Further Evaluation” or “Site Not Suitable,” as described below.

- **Acceptable Site**
“Acceptable Site” means that the site fully satisfies the acceptance criteria specified in the template and no hazards were identified.
- **Challenged Site Requiring Further Evaluation**
“Challenged Site Requiring Further Evaluation” means that hazards were identified, a characteristic could not be adequately evaluated or that the acceptance criteria were not fully satisfied but that compensatory factors or other forms of mitigation may be indicated.
- **Site Not Suitable**
“Site Not Suitable” generally means that hazards were identified for which no remedy is feasible or that the site failed to satisfy the specified criteria for the characteristic being evaluated and there appear to be no reasonable (or cost-effective) alternatives to make the site acceptable.

The evaluator will provide a discussion of the evaluation methodology and results in the “Discussion” section of the template, including a list of applicable references. This discussion should characterize the process to a level that sets the framework for additional analysis should the proposed site be carried forward as an Acceptable Site.

5.2 Specialized Evaluation Process

The templates are configured on the assumption that design of a particular technology is suitably advanced to provide information sufficient to demonstrate that the design of the facility will fall within the site characteristics and design parameters.

However, since at the time of this procedure development the reactor designs were still in the conceptual design phase, it should be noted that some design parameters may not be known at the time of the feasibility assessment. This procedure can be adapted to collect information which can then be used to further develop the design. In those cases the evaluator is expected to characterize the design features of the site related to the parameter. The evaluator will be unable to draw any conclusions regarding site acceptability, but

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will be able to assess and document site attributes and limitations that should be considered by the plant designers.

The steps of the evaluation process will be similar to those described above in 5.1 with some variation. During the first step of the evaluation process, the reactor vendor's information needs should be established to ensure applicable modifications to the templates are made, if needed.

For those site assessment areas where design information is not known or is limited, assessment results should be documented in an observation summary format, rather than with the "pass, further evaluation, or fail" criteria described in the templates.

6.0 Documentation of Results

6.1 Quality Assurance

Because the assessment process described herein normally would utilize existing data and analyses, it is anticipated that the process would not be subject to 10CFR50 Appendix B Quality Assurance requirements. However, since the information that is evaluated could be used in a future license application (e.g., an Environmental Report description of site selection), appropriate quality elements should be considered in order to ensure the accuracy and quality of the information collected and the evaluations performed. One way to accomplish this is through development and adherence to an assessment quality plan. If it is anticipated that some of the information will be used in future analyses that may be subject to 10CFR50 Appendix B Quality Assurance requirements, the requirements of 10CFR52.17(a)(1)(xi) and 10CFR52.79(a)(25) should be considered.

6.2 Compilation of Results

The results of the site hazards evaluations should be compiled into a final report that provides an overall conclusion with regard to suitability of the site for the applicable technology(ies) with respect to the hazards considered. As discussed in Section 6.1, if the results of the assessment might be used in a future licensing application, then appropriate quality measures should be considered and applied as appropriate. These measures should include validation of methodologies and inputs used, and review by qualified personnel.

The final report should be structured to contain the following minimum elements:

Executive Summary (text description of overall conclusions about the site)

Report Body

- o Table of Contents
- o Summary description of assessment process
- o Summary description of assessment results
- o Assessment conclusions

Attachments

- o Project and site owner requirements
- o General drawing/picture of evaluated site with key features shown (e.g. proposed plant location, property lines)

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- Summary table of site characteristic evaluation results [NOTE: for those assessment areas where design information was not available at the time of the assessment, the table should reflect a summary of the parameter observed rather than the “pass”, “fail”, or “further evaluation” criteria]
- Site characteristic evaluation worksheets
- List of persons/organizations contacted
- List of persons performing assessment including area(s) of expertise
- Completed Plant Parameter Worksheet

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7.0 References

- 7.1 Entergy Nuclear, "Site Selection Criteria Guidelines for an Early Site Permit" (Entergy, 2001).
- 7.2 Electric Power Research Institute, "Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application" (EPRI, March 2002).
- 7.3 U. S. Nuclear Regulatory Commission, NUREG-0800, "Standard Review Plan" (USNRC, March 2007).
- 7.4 U. S. Nuclear Regulatory Commission, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants," NUREG-1555, Draft Revision 1 (USNRC, July 2007).
- 7.5 10 CFR Part 100, Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997."
- 7.6 U. S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," April 1998 (USNRC, April 1998).
- 7.7 U. S. Nuclear Regulatory Commission, Draft Regulatory Guide DG-4015, Proposed Revision 1 of Regulatory Guide 4.2, Supplement 1, dated September 2000, Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications," USNRC, September 2000.

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Appendix A
Plant Parameter Definitions

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Appendix A, Plant Parameter Definitions

Parameter	Units	Definition
1.1 Building Characteristics		
1.1.1 Height	Feet	The height from finished grade to the top of the tallest power block structure, excluding cooling towers.
1.1.2 Foundation Embedment	Feet	The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure.
1.2 Precipitation (for Roof Design)		
1.2.1 Maximum Rainfall Rate	Inches per hour/ Inches in 5 minutes	The probable maximum precipitation (PMP) value that can be accommodated by a plant design. Expressed as maximum precipitation for 1 hour in 1 square mile with a ratio for five minutes to the 1 hour PMP of .32 as found in National Weather Service Publication HMR No. 52.
1.2.2 Snow & Ice Load	Pounds per square foot	The maximum load on structure roofs due to the accumulation of snow and ice that can be accommodated by a plant design.
1.3 Safe Shutdown Earthquake (SSE)		
1.3.1 Design Response Spectra		The assumed design response spectra used to establish a plant's seismic design.
1.3.2 Peak Ground Acceleration	Fraction of gravity acceleration	The maximum earthquake ground acceleration for which a plant is designed; this is defined as the acceleration which corresponds to the zero period in the response spectra taken in the free field at plant grade elevation.
1.3.3 Time History	N/A	The plot of earthquake ground motion as a function of time used to establish a plant's seismic design.
1.3.4 Capable Tectonic Structures or Sources	N/A	The assumption made in a plant design about the presence of capable faults or earthquake sources in the vicinity of the plant site (e.g., No fault displacement potential within the investigative area).
1.4 Site Water Level (Allowable)		
1.4.1 Maximum Flood (or Tsunami)	Feet	Design assumption regarding the difference in elevation between finished plant grade and the water level due to the probable maximum flood and probable maximum precipitation (defined in ANSI/ANS 2.8-1992) used in the plant design.
1.4.2 Maximum Ground Water	Feet	Design assumption regarding the difference in elevation between finished plant grade and the maximum site ground water level used in the plant design.
1.5 Soil Properties Design Bases		
1.5.1 Liquefaction	N/A	Design assumption regarding the presence of potentially liquefying soils at a site (e.g., None at Site-Specific SSE)
1.5.2 Minimum Bearing Capacity (Static)	Pounds per square foot	Design assumption regarding the capacity of the competent load-bearing layer required to support the loads exerted by plant structures used in the plant design.
1.5.3 Minimum Shear Wave Velocity	Feet per second	The assumed limiting propagation velocity of shear waves through the foundation materials used in the plant design.
1.6 Tornado (Design Bases)		
1.6.1 Maximum Pressure Drop	Pounds per square inch	The design assumption for the decrease in ambient pressure from normal atmospheric pressure due to the passage of the tornado.
1.6.2 Maximum Rotational Speed	Miles per hour	The design assumption for the component of tornado wind speed due to the rotation within the tornado.
1.6.3 Maximum Translational Speed	Miles per hour	The design assumption for the component of tornado wind speed due to the movement of the tornado over the ground.
1.6.4 Maximum Wind Speed	Miles per hour	The design assumption for the sum of maximum rotational and maximum translational wind speed components.
1.6.5 Missile Spectra	Units as appropriate.	The design assumptions regarding missiles that could be ejected either horizontally or vertically from a tornado. The spectra identify mass, dimensions and velocity of credible missiles.

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Appendix A, Plant Parameter Definitions

Parameter	Units	Definition
1.6.6 Radius of Maximum Rotational Speed	Feet	The design assumption for distance from the center of the tornado at which the maximum rotational wind speed occurs.
1.6.7 Rate of Pressure Drop	Pounds per square inch per second	The assumed design rate at which the pressure drops due to the passage of the tornado.
1.7 Wind		
1.7.1 Basic Wind Speed	Miles per hour	The design wind, or "fastest mile of wind" with a 100-year return period (NUREG-0800, Sections 2.3.1 and 3.3.1) for which the facility is designed.
1.7.2 Importance Factors	N/A	Multiplication factors (as defined in ANSI A58.1-1982) applied to basic wind speed to develop the plant design.
2. Normal Plant Heat Sink		
2.1 Ambient Air Requirements		
2.1.1 Normal Shutdown Max Ambient Temp (1% Exceedance)	°F	Assumption used for the maximum ambient temperature that will be exceeded no more than 1% of the time, to design plant systems capable of effecting normal shutdown under the assumed temperature condition.
2.1.2 Normal Shutdown Max Wet Bulb Temp (1% Exceedance)	°F	Assumption used for the maximum wet bulb temperature that will be exceeded no more than 1% of the time – used in design of plant systems that must be capable of effecting normal shutdown under the assumed temperature condition.
2.1.3 Normal Shutdown Min Ambient Temp (1% Exceedance)	°F	Assumption used for the minimum ambient temperature that will be exceeded no more than 1% of the time to design of plant systems that must be capable of effecting normal shutdown under the assumed temperature condition.
2.1.4 Rx Thermal Power Max Ambient Temp (0% Exceedance)	°F	Assumption used for the maximum ambient temperature that will never be exceeded – used in design of plant systems that must be capable of supporting full power operation under the assumed temperature condition.
2.1.5 Rx Thermal Power Max Wet Bulb Temp (0% Exceedance)	°F	Assumption used for the maximum wet bulb temperature that will never be exceeded – used in design of plant systems that must be capable of supporting full power operation under the assumed temperature condition.
2.1.6 Rx Thermal Power Min Ambient Temp (0% Exceedance)	°F	Assumption used for the minimum ambient temperature that will never be exceeded – used in design of plant systems that must be capable of supporting full power operation under the assumed temperature condition.
2.2 Blowdown Pond Acreage (24 hr blowdown)	Acres	The land usage required to provide a pond with a capacity to provide holdup for 24 hours of blowdown water from the plant.
2.3 Condenser		
2.3.1 Max Inlet Temp Condenser/ Heat Exchanger	°F	Design assumption for the maximum acceptable circulating water temperature at the inlet to the condenser or cooling water system heat exchanges
2.3.2 Condenser / Heat Exchanger Duty	BTU per hour	Design value for the waste heat rejected to the circulating water system across the condensers.

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Appendix A, Plant Parameter Definitions

Parameter	Units	Definition
2.4 Mechanical Draft Cooling Towers		
2.5 Natural Draft Cooling Towers		
2.7 Ponds		
2.4.1, 2.5.1, 2.7.1 Acreage	Acres	The land required for cooling towers or ponds, including support facilities such as equipment sheds, basins, canals, or shoreline buffer areas.
2.4.2, 2.5.2 Approach Temperature	°F	The difference between the cold water temperature and the ambient wet bulb temperature.
2.4.3, 2.5.3, 2.7.2 Blowdown Constituents and Concentrations	Parts per million	The maximum expected concentrations for anticipated constituents in the cooling water systems blowdown to the receiving water body.
2.4.4, 2.5.4, 2.7.3 Blowdown Flow Rate	Gallons per minute	The normal (and maximum) flow rate of the blowdown stream from the cooling water systems to the receiving water body for closed system designs.
2.4.5, 2.5.5, 2.7.4 Blowdown Temperature	°F	The maximum expected blowdown temperature at the point of discharge to the receiving water body.
2.4.6, 2.5.6, 2.7.5 Cycles of Concentration	Number	The ratio of total dissolved solids in the cooling water blowdown streams to the total dissolved solids in the makeup water streams.
2.4.7, 2.5.7, 2.7.6 Evaporation Rate	Gallons per minute	The expected (and maximum) rate at which water is lost by evaporation from the cooling water systems.
2.4.8, 2.5.8 Height	Feet	The vertical height above finished grade of either natural draft or mechanical draft cooling towers associated with the cooling water systems.
2.4.9, 2.5.9, & 2.7.8 Makeup Flow Rate	Gallons per minute	The expected (and maximum) rate of removal of water from a natural source to replace water losses from closed cooling water systems
2.4.10, 2.5.10 Noise	Decibels	The maximum expected sound level produced by operation of cooling towers, measured at 1000 feet from the noise source.
2.4.11, 2.5.11, 2.7.10 Cooling Tower/Pond Temperature Range	°F	The temperature difference between the cooling water entering and leaving the towers or ponds.
2.4.12, 2.5.12, 2.7.11 Cooling Water Flow Rate	Gallons per minute	The total cooling water flow rate through the condenser/heat exchangers.
2.4.13, 2.5.13, 2.7.7 Heat Rejection Rate (blowdown)	Gallons per minute @ °F	The expected heat rejection rate to a receiving water body, expressed as flow rate in gallons per minute at a temperature in degrees Fahrenheit.

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Parameter	Units	Definition
2.4.14, 2.5.14, 2.7.12 Maximum Consumption of Raw Water	Gallons per minute	The expected maximum short-term consumptive use of water by the cooling water systems (evaporation and drift losses).
2.4.15, 2.5.15, 2.7.13 Monthly Average Consumption of Raw Water	Gallons per minute	The expected normal operating consumption of water by the cooling water systems (evaporation and drift losses).
2.4.16, 2.5.16, 2.7.9 Stored Water Volume	Gallons	The quantity of water stored in cooling water system impoundments, basins, tanks and/or ponds.
2.6 Once-Through Cooling		
2.6.1 Cooling Water Discharge Temperature	°F	Expected temperature of the cooling water at the exit of the condenser/heat exchangers.
2.6.2 Cooling Water Flow Rate	Gallons per minute	Total cooling water flow rate through the condenser (also the rate of withdrawal from and return to the water source).
2.6.3 Cooling Water Temperature Rise	°F	Temperature rise across the condenser (temperature of water out minus temperature of water in).
2.6.4 Evaporation Rate	Gallons per minute	The expected (and maximum) rate at which water is lost by evaporation from the receiving water body as a result of heating in the condenser.
2.6.5 Heat Rejection Rate	BTU per hour	The expected heat rejection rate to a receiving water body.
3. Ultimate Heat Sink		
3.1 Ambient Air Requirements		
3.1.1 Maximum Ambient Temperature (0% Exceedance)	°F	Assumption used for the maximum ambient temperature in designing the UHS system to provide heat rejection for 30 days under the assumed temperature condition.
3.1.2 Maximum Wet Bulb Temperature (0% Exceedance)	°F	Assumption used for the maximum wet bulb temperature in designing the UHS system to provide heat rejection for 30 days under the assumed temperature condition.
3.1.3 Minimum Ambient Temperature (0% Exceedance)	°F	Assumption used for the minimum ambient temperature in designing the UHS system to provide heat rejection for 30 days under the assumed temperature condition.
3.2 CCW Heat Exchanger		
3.2.1 Maximum Inlet Temp to CCW Heat Exchanger	°F	The maximum temperature of safety-related service water at the inlet of the UHS component cooling water heat exchanger.
3.2.2 CCW Heat Exchanger Duty	BTU per hour	The heat transferred to the safety-related service water system for rejection to the environment in UHS heat removal devices.
3.3 Mechanical Draft Cooling Towers		
3.5 Ponds		
3.3.1, 3.5.1 Acreage	Acres	The land required for UHS cooling towers or ponds, including support facilities such as equipment sheds, basins, canals, or shoreline buffer areas.

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Parameter	Units	Definition
3.3.2 Approach Temperature	°F	The difference between the cold water temperature and the ambient wet bulb temperature.
3.3.3, 3.5.2 Blowdown Constituents and Concentrations	Parts per million	The maximum expected concentrations for anticipated constituents in the UHS blowdown to the receiving water body.
3.3.4, 3.5.3 Blowdown Flow Rate	Gallons per minute	The normal (and maximum) flow rate of the blowdown stream from the UHS system to receiving water body for closed system designs.
3.3.5, 3.5.4 Blowdown Temperature	°F	The maximum expected UHS blowdown temperature at the point of discharge to the receiving water body.
3.3.6, 3.5.5 Cycles of Concentration	Number	The ratio of total dissolved solids in the UHS system blowdown streams to the total dissolved solids in the makeup water streams.
3.3.7, 3.5.6 Evaporation Rate	Gallons per minute	The expected (and maximum) rate at which water is lost by evaporation from the UHS system.
3.3.8 Height	Feet	The vertical height above finished grade of mechanical draft cooling towers associated with the UHS system
3.3.9, 3.5.7 Makeup Flow Rate	Gallons per minute	The expected (and maximum) rate of removal of water from a natural source to replace water losses from the UHS system.
3.3.10 Noise	Decibels	The maximum expected sound level produced by operation of mechanical draft UHS cooling towers, measured at 1000 feet from the noise source.
3.3.11, 3.5.8 Cooling Tower/Pond Temperature Range	°F	The temperature difference between the cooling water entering and leaving the UHS system.
3.3.12, 3.5.9 Cooling Water Flow Rate	Gallons per minute	The total cooling water flow rate through the UHS system.
3.3.13, 3.5.10 Heat Rejection Rate (blowdown)	Gallons per minute @ °F	The expected heat rejection rate to a receiving water body, expressed as flow rate in gallons per minute at a temperature in degrees Fahrenheit.
3.3.14, 3.5.11 Maximum Consumption of Raw Water	Gallons per minute	The expected maximum short-term consumptive use of water by the UHS system (evaporation and drift losses).
3.3.15, 3.5.12 Monthly Average Consumption of Raw Water	Gallons per minute	The expected normal operating consumption of water by the UHS system (evaporation and drift losses).
3.3.16, 3.5.13 Stored Water Volume	Gallons	The quantity of water stored in UHS impoundments, basins, tanks and/or ponds.

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Parameter	Units	Definition
3.4 Once-Through Cooling		
3.4.1 Cooling Water Discharge Temperature	°F	Expected temperature of the cooling water at the exit of the UHS system.
3.4.2 Cooling Water Flow Rate	Gallons per minute	Total cooling water flow rate through the UHS (also the rate of withdrawal from and return to the water source).
3.4.3 Cooling Water Temperature Rise	°F	Temperature rise across the heat exchangers cooled by the UHS (temperature of water out minus temperature of water in).
3.4.4 Minimum Essential Flow Rate	Gallons per minute	Minimum flow required to maintain required heat removal capacity under design-basis accident conditions.
3.4.5 Evaporation Rate	Gallons per minute	The expected (and maximum) rate at which water is lost by evaporation from the UHS a result of heat rejection from the plant.
3.4.6 Heat Rejection Rate	BTU per hour	The expected heat rejection rate to the UHS.
4. Containment Heat Removal System (Post-Accident)		
4.1 Ambient Air Requirements		
4.1.1 Maximum Ambient Air Temperature (0% Exceedance)	°F	Assumed maximum ambient temperature used in designing the containment heat removal system.
4.1.2 Minimum Ambient Temperature (0% Exceedance)	°F	Assumed minimum ambient temperature used in designing the containment heat removal system.
5. Potable Water/Sanitary Waste System		
5.1 Discharge to Site Water Bodies		
5.1.1 Flow Rate	Gallons per minute	The expected (and maximum) effluent flow rate from the potable and sanitary waste water systems to the receiving water body.
5.2 Raw Water Requirements		
5.2.1 Maximum Use	Gallons per minute	The maximum short-term rate of withdrawal from the water source for the potable and sanitary waste water systems.
5.2.2 Monthly Average Use	Gallons per minute	The average rate of withdrawal from the water source for the potable and sanitary waste water systems.
6. Demineralized Water System		
6.1 Discharge to Site Water Bodies		
6.1.1 Flow Rate	Gallons per minute	The expected (and maximum) effluent flow rate from the demineralized system to the receiving water body.
6.2 Raw Water Requirements		
6.2.1 Maximum Use	Gallons per minute	The maximum short-term rate of withdrawal from the water source for the demineralized water system.
6.2.2 Monthly Average Use	Gallons per minute	The average rate of withdrawal from the water source for the demineralized water system.

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Parameter	Units	Definition
7. Fire Protection System		
7.1 Raw Water Requirements		
7.1.1 Maximum Use	Gallons per minute	The maximum short-term rate of withdrawal from the water source for the fire protection water system.
7.1.2 Monthly Average Use	Gallons per minute	The average rate of withdrawal from the water source for the fire protection water system.
7.1.3 Stored Water Volume	Gallons	The quantity of water stored in fire protection system impoundments, basins or tanks
8. Miscellaneous Drain		
8.1 Discharge to Site Water Bodies		
8.1.1 Flow Rate	Gallons per minute	The expected (and maximum) effluent flow rate from miscellaneous drains to the receiving water body.
9. Unit Vent/Airborne Effluent Release Point		
9.1 Atmospheric Dispersion (CHI/Q) (Accident)		
9.1.1 0-2 hr @ EAB	Seconds per meter cubed	The atmospheric dispersion coefficients used in the design safety analysis to estimate dose consequences of accident airborne releases.
9.1.2 0-8 hr @ LPZ		
9.1.5 8-24 hr @ LPZ		
9.1.3 1-4 day @ LPZ		
9.1.4 4-30 day @ LPZ		
9.2 Atmospheric Dispersion (CHI/Q) (Annual Average)	Seconds per meter cubed	The atmospheric dispersion coefficients used in the safety analysis for the dose consequences of normal airborne releases.
9.3 Dose Consequences		
9.3.1 Normal	REM	The estimated design radiological dose consequences due to gaseous releases from normal operation of the plant.
9.3.2 Post-Accident	REM	The estimated design radiological dose consequences due to gaseous releases from postulated accidents.
9.3.3 Severe Accidents	See Definition column	Pending resolution of ESP-12.
9.4 Release Point		
9.4.1 Configuration	Horizontal or Vertical	The orientation of the release point discharge flow
9.4.2 Elevation (Normal Operation)	Feet	The elevation above finished grade of the release point for routine operational releases.
9.4.3 Elevation (Post Accident)	Feet	The elevation above finished grade of the release point for accident sequence releases.
9.4.4 Minimum Distance to Site Boundary	Feet	The minimum lateral distance from the release point to the site boundary.
9.4.5 Temperature	°F	The temperature of the airborne effluent stream at the release point.

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Parameter	Units	Definition
9.4.6 Volumetric Flow Rate	Standard Cubic Feet per Minute	The volumetric flow rate of the airborne effluent stream at the release point.
9.5 Source Term		
9.5.1 Gaseous (Normal)	Curies per year	The annual activity, by isotope, contained in routine plant airborne effluent streams.
9.5.2 Gaseous (Post-Accident)	Curies	The activity, by isotope, contained in post-accident airborne effluents.
9.5.3 Tritium	Curies per year	The annual activity of tritium contained in routine plant airborne effluent streams.
10. Liquid Radwaste System		
10.1 Dose Consequences		
10.1.1 Normal	REM	The estimated design radiological dose consequences due to liquid effluent releases from normal operation of the plant.
10.1.2 Post-Accident	REM	The estimated design radiological dose consequences due to liquid effluent releases from postulated accidents.
10.2 Release Point		
10.2.1 Flow Rate	Gallons per minute	The discharge (including minimum dilution flow, if any) of liquid potentially radioactive effluent streams from plant systems to the receiving water body.
10.3 Source Term		
10.3.1 Liquid	Curies per year	The annual activity, by isotope, contained in routine plant liquid effluent streams.
10.3.2 Tritium	Curies per year	The annual activity of tritium contained in routine plant liquid effluent streams.
11. Solid Radwaste System		
11.1 Acreage		
11.1.1 Low Level Radwaste Storage	Acres	The land usage required to provide onsite storage of low level radioactive wastes.
11.2 Solid Radwaste		
11.2.1 Activity	Curies per year	The annual activity, by isotope, contained in solid radioactive wastes generated during routine plant operations.
11.2.2 Principal Radionuclides	Curies per year	The principal radionuclides contained in solid radioactive wastes generated during routine plant operations.
11.2.3 Volume	Cubic feet per year	The expected volume of solid radioactive wastes generated during routine plant operations.
12. Spent Fuel Storage		
12.1 Spent Fuel Dry Storage		
12.1.1 Acreage	Acres	The land usage required to provide onsite dry storage of spent fuel for the expected plant lifetime, including the fenced off area necessary to provide an acceptable radiation protection and security zone.
12.1.2 Minimum Distance to Nearest Residence	Feet	The minimum distance from the spent fuel dry storage facility to the nearest residence to ensure that radiation exposures meet 10CFR72 limitations.

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Parameter	Units	Definition
12.1.3 Minimum Distance to Power Block	Feet	The minimum distance from spent fuel dry storage facility to the nearest unit power block necessary to ensure that occupational radiation exposures meet 10CFR20 requirements.
12.1.4 Storage Capacity	Years	The years of plant operation for which spent fuel dry storage should be provided without taking credit for capacity in the spent fuel pool.
13. Auxiliary Boiler System		
13.1 Exhaust Elevation	Feet	The height above finished plant grade at which the flue gas effluents are released to the environment.
13.2 Flue Gas Effluents	Pounds per year	The expected combustion products and anticipated quantities released to the environment due to operation of the auxiliary boilers, diesel engines and gas turbines.
13.3 Fuel Type	N/A	The type of fuel oil required for proper operation of the auxiliary boilers, diesel engines and gas turbines.
13.4 Heat Input Rate	BTU per hour	The average heat input rate due to the periodic operation of the auxiliary boilers.
14. Heating, Ventilation and Air Conditioning System		
14.1 Ambient Air Requirements		
14.1.1 Non-safety HVAC max ambient temp (1% Exceedance)	°F	Assumption used for the maximum ambient temperature that will be exceeded no more than 1% of the time, to design the non-safety HVAC systems.
14.1.2 Non-safety HVAC min ambient temp (1% Exceedance)	°F	Assumption used for the minimum ambient temperature that will be exceeded no more than 1% of the time, to design the non-safety HVAC systems.
14.1.3 Safety HVAC max ambient temp (0% Exceedance)	°F	Assumption used for the maximum ambient temperature that will never be exceeded, to design the safety-related HVAC systems.
14.1.4 Safety HVAC min ambient temp (0% Exceedance)	°F	Assumption used for the minimum ambient temperature that will never be exceeded, to design the safety-related HVAC systems.
14.1.5 Vent System max ambient temp (5% Exceedance)	°F	Assumption used for the maximum ambient temperature that will be exceeded no more than 5% of the time to design the non-HVAC ventilation systems.
14.1.6 Vent System min ambient temp (5% Exceedance)	°F	Assumption used for the minimum ambient temperature that will be exceeded no more than 5% of the time to design the non-HVAC ventilation systems.
15. Onsite/Offsite Electrical Power System		
15.1 Acreage		
15.1.1 Switchyard	Acres	The land usage required for the high voltage switchyard used to connect the plant to the transmission grid.
16. Standby Power System		
16.1 Diesel		
16.1.1 Diesel Capacity	Kilowatts	The capacity of diesel engines used for generation of standby electrical power
16.1.2 Diesel Exhaust Elevation	Feet	The elevation above finished grade of the release point for standby diesel exhaust releases.

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Parameter	Units	Definition
16.1.3 Diesel Flue Gas Effluents	Pounds per year	The expected combustion products and anticipated quantities released to the environment due to operation of the emergency standby diesel generators.
16.1.4 Diesel Noise	Decibels	The maximum expected sound level produced by operation of diesel engines turbines, measured at 50 feet from the noise source.
16.1.5 Diesel Fuel Type	N/A	The type of fuel oil required for proper operation of the diesel engines.
16.2 Gas-Turbine		
16.2.1 Gas-Turbine Capacity	Kilowatts	The capacity of gas-turbines used for generation of standby electrical power.
16.2.2 Gas-Turbine Exhaust Elevation	Feet	The elevation above finished grade of the release point for standby gas-turbine exhaust releases.
16.2.3 Gas-Turbine Flue Gas Effluents	Pounds per year	The expected combustion products and anticipated quantities released to the environment due to operation of the emergency standby gas-turbine generators.
16.2.4 Gas-Turbine Noise	Decibels	The maximum expected sound level produced by operation of gas-turbines, measured at 50 feet from the noise source.
16.2.5 Gas-Turbine Fuel Type	N/A	The type of fuel oil required for proper operation of the gas-turbines.
17. Plant Characteristics		
17.1 Access Routes		
17.1.1 Heavy Haul Routes	Acres	The land usage required for permanent heavy haul routes to support normal operations and refueling.
17.1.2 Spent Fuel Cask Weight	Tons	The weight of the heaviest expected shipment during normal plant operations and refueling.
17.2 Acreage	Acres	The land area required to provide space for plant facilities.
17.2.1 Office Facilities		
17.2.2 Parking Lots		
17.2.3 Permanent Support Facilities		
17.2.4 Power Block		
17.2.5 Protected Area		
17.3 Megawatts Thermal	Mega-watts	The thermal power generated by all units.
17.4 Plant Design Life	Years	The operational life for which the plant is designed.
17.5 Plant Population		
17.5.1 Operation	Persons	The number of people required to operate and maintain the plant.
17.5.2 Refueling / Major Maintenance	Persons	The additional number of temporary staff required to conduct refueling and major maintenance activities.

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Parameter	Units	Definition
17.6 Station Capacity Factor	Percent	The percentage of time that a plant is capable of providing power to the grid.
18. Construction		
18.1 Access Routes		
18.1.1 Construction Module Dimensions	Feet	The maximum expected length, width, and height of the largest construction modules or components and delivery vehicles to be transported to the site during construction.
18.1.2 Heaviest Construction Shipment	Tons	The maximum expected weight of the heaviest construction shipment to the site.
18.2 Acreage		
18.2.1 Laydown Area	Acres	The land area required to provide space for construction support facilities.
18.2.2 Temporary Construction Facilities		
18.3 Construction		
18.3.1 Noise	Decibels	The maximum expected sound level due to construction activities, measured at 50 feet from the noise source.
18.4 Plant Population		
18.4.1 Construction	Persons	Peak employment during plant construction.
18.5 Site Preparation Duration	Months	Length of time required to prepare the site for construction.

Note: this is a listing of design parameters believed to be relevant to the HTGR based on current available information. Since the designs are still in the conceptual design phase new parameters may evolve or existing parameters may change or become inapplicable to the reactor design being evaluated. For example, whether or not a LWR-type containment will be required or what its performance requirements might be is unresolved as of the time of development of this procedure.

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APPENDIX B

PLANT PARAMETER WORKSHEET

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Instructions: Fill in values for each design parameter available from each reactor technology vendor under consideration for the site. If the parameter is not applicable for a reactor/plant, enter "N/A" in the data field. If a bounding number is entered, so state. If explanation is needed in order to clarify the number, include the explanation in the "value" space. For modular plants, state whether the value is per unit or for some combination of units. If the value is contingent on some other value or embedded assumption, so state (e.g. contingent on MW).

Since the reactor designs are still in the conceptual design phase it should be noted that some design parameters may not be known at the time of the feasibility assessment. In those cases the evaluator is expected to characterize the design features of the site related to the parameter. The evaluator will be unable to draw any conclusions regarding site acceptability, but will be able to assess and document site attributes and limitations that should be considered by the plant designers..

Note: this is a listing of design parameters believed to be relevant to the HTGR based on current available information. Since the designs are still in the conceptual design phase new parameters may evolve or existing parameters may change or become non-applicable to the reactor design being evaluated. For example whether or not a LWR-type containment will be required or what's its performance requirements might be is unresolved as of the time of development of this procedure.

See procedure text for additional instructions.

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APPLICABLE REACTOR TECHNOLOGY: _____

Parameter	Units	VALUE
1. Structures		
1.1 Building Characteristics		
1.1.1 Height	Feet	
1.1.2 Foundation Embedment	Feet	
1.2 Precipitation (for Roof Design)		
1.2.1 Maximum Rainfall Rate	Inches per hour/ Inches in 5 minutes	
1.2.2 Snow & Ice Load	Pounds per square foot	
1.3 Safe Shutdown Earthquake (SSE)		
1.3.1 Design Response Spectra		
1.3.2 Peak Ground Acceleration	Fraction of gravity acceleration	
1.3.3 Time History	N/A	
1.3.4 Capable Tectonic Structures or Sources	N/A	
1.4 Site Water Level (Allowable)		
1.4.1 Maximum Flood (or Tsunami)	Feet	
1.4.2 Maximum Ground Water	Feet	
1.5 Soil Properties Design Bases		
1.5.1 Liquefaction	N/A	
1.5.2 Minimum Bearing Capacity (Static)	Pounds per square foot	
1.5.3 Minimum Shear Wave Velocity	Feet per second	
1.6 Tornado (Design Bases)		
1.6.1 Maximum Pressure Drop	Pounds per square inch	
1.6.2 Maximum Rotational Speed	Miles per hour	
1.6.3 Maximum Translational Speed	Miles per hour	

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Parameter	Units	VALUE
1.6.4 Maximum Wind Speed	Miles per hour	
1.6.5 Missile Spectra	Units as appropriate.	
1.6.6 Radius of Maximum Rotational Speed	Feet	
1.6.7 Rate of Pressure Drop	Pounds per square inch per second	
1.7 Wind		
1.7.1 Basic Wind Speed	Miles per hour	
1.7.2 Importance Factors	N/A	
2. Normal Plant Heat Sink		
2.1 Ambient Air Requirements		
2.1.1 Normal Shutdown Max Ambient Temp (1% Exceedance)	°F	
2.1.2 Normal Shutdown Max Wet Bulb Temp (1% Exceedance)	°F	
2.1.3 Normal Shutdown Min Ambient Temp (1% Exceedance)	°F	
2.1.4 Rx Thermal Power Max Ambient Temp (0% Exceedance)	°F	
2.1.5 Rx Thermal Power Max Wet Bulb Temp (0% Exceedance)	°F	
2.1.6 Rx Thermal Power Min Ambient Temp (0% Exceedance)	°F	
2.2 Blowdown Pond Acreage (24 hr blowdown)	Acres	
2.3 Condenser		
2.3.1 Max Inlet Temp Condenser/ Heat Exchanger	°F	
2.3.2 Condenser / Heat Exchanger Duty	BTU per hour	
2.4 Mechanical Draft Cooling Towers		
2.4.1 Acreage	Acres	
2.4.2 Approach Temperature	°F	
2.4.3 Blowdown Constituents and Concentrations	Parts per million	

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Parameter	Units	VALUE
2.4.4 Blowdown Flow Rate	Gallons per minute	
2.4.5 Blowdown Temperature	°F	
2.4.6 Cycles of Concentration	Number	
2.4.7 Evaporation Rate	Gallons per minute	
2.4.8 Height	Feet	
2.4.9 Makeup Flow Rate	Gallons per minute	
2.4.10 Noise	Decibels	
2.4.11 Cooling Tower Temperature Range	°F	
2.4.12 Cooling Water Flow Rate	Gallons per minute	
2.4.13 Heat Rejection Rate (Blowdown)	Gallons per minute @ °F	
2.4.14 Maximum Consumption of Raw Water	Gallons per minute	
2.4.15 Monthly Average Consumption of Raw Water	Gallons per minute	
2.4.16 Stored Water Volume	Gallons	
2.5 Natural Draft Cooling Towers		
2.5.1 Acreage	Acres	
2.5.2 Approach Temperature	°F	
2.5.3 Blowdown Constituents and Concentrations	Parts per million	
2.5.4 Blowdown Flow Rate	Gallons per minute	
2.5.5 Blowdown Temperature	°F	
2.5.6 Cycles of Concentration	Number	
2.5.7 Evaporation Rate	Gallons per minute	
2.5.8 Height	Feet	
2.5.9 Makeup Flow Rate	Gallons per minute	
2.5.10 Noise	Decibels	
2.5.11 Cooling Tower Temperature Range	°F	
2.5.12 Cooling Water Flow Rate	Gallons per minute	
2.5.13 Heat Rejection Rate (Blowdown)	Gallons per minute @ °F	

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Parameter	Units	VALUE
2.5.14 Maximum Consumption of Raw Water	Gallons per minute	
2.5.15 Monthly Average Consumption of Raw Water	Gallons per minute	
2.5.16 Stored Water Volume	Gallons	
2.6 Once-Through Cooling		
2.6.1 Cooling Water Discharge Temperature	°F	
2.6.2 Cooling Water Flow Rate	Gallons per minute	
2.6.3 Cooling Water Temperature Rise	°F	
2.6.4 Evaporation Rate	Gallons per minute	
2.6.5 Heat Rejection Rate	BTU per hour	
2.7 Ponds		
2.7.1 Acreage	Acres	
2.7.2 Blowdown Constituents and Concentrations	Parts per million	
2.7.3 Blowdown Flow Rate	Gallons per minute	
2.7.4 Blowdown Temperature	°F	
2.7.5 Cycles of Concentration	Number	
2.7.6 Evaporation Rate	Gallons per minute	
2.7.7 Heat Rejection Rate (Blowdown)	Gallons per minute @ °F	
2.7.8 Makeup Flow Rate	Gallons per minute	
2.7.9 Stored Water Volume	Gallons	
2.7.10 Cooling Pond Temperature Range	°F	
2.7.11 Cooling Water Flow Rate	Gallons per minute	
2.7.12 Maximum Consumption of Raw Water	Gallons per minute	
2.7.13 Monthly Average Consumption of Raw Water	Gallons per minute	

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Parameter	Units	VALUE
3. Ultimate Heat Sink		
3.1 Ambient Air Requirements		
3.1.1 Maximum Ambient Temp (0% Exceedance)	°F	
3.1.2 Maximum Wet Bulb Temp (0% Exceedance)	°F	
3.1.3 Minimum Ambient Temp (0% Exceedance)	°F	
3.2 CCW Heat Exchanger		
3.2.1 Maximum Inlet Temp to CCW Heat Exchanger	°F	
3.2.2 CCW Heat Exchanger Duty	BTU per hour	
3.3 Mechanical Draft Cooling Towers		
3.3.1 Acreage	Acres	
3.3.2 Approach Temperature	°F	
3.3.3 Blowdown Constituents and Concentrations	Parts per million	
3.3.4 Blowdown Flow Rate	Gallons per minute	
3.3.5 Blowdown Temperature	°F	
3.3.6 Cycles of Concentration	Number	
3.3.7 Evaporation Rate	Gallons per minute	
3.3.8 Height	Feet	
3.3.9 Makeup Flow Rate	Gallons per minute	
3.3.10 Noise	Decibels	
3.3.11 Cooling Tower Temperature Range	°F	
3.3.12 Cooling Water Flow Rate	Gallons per minute	
3.3.13 Heat Rejection Rate (Blowdown)	Gallons per minute @ °F	
3.3.14 Maximum Consumption of Raw Water	Gallons per minute	
3.3.15 Monthly Average Consumption of Raw Water	Gallons per minute	
3.3.16 Stored Water Volume	Gallons	

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Parameter	Units	VALUE
3.4 Once-Through Cooling		
3.4.1 Cooling Water Discharge Temperature	°F	
3.4.2 Cooling Water Flow Rate	Gallons per minute	
3.4.3 Cooling Water Temperature Rise	°F	
3.4.4 Minimum Essential Flow Rate	Gallons per minute	
3.4.5 Evaporation Rate	Gallons per minute	
3.4.6 Heat Rejection Rate	BTU per hour	
3.5 Ponds		
3.5.1 Acreage	Acres	
3.5.2 Blowdown Constituents and Concentrations	Parts per million	
3.5.3 Blowdown Flow Rate	Gallons per minute	
3.5.4 Blowdown Temperature	°F	
3.5.5 Cycles of Concentration	Number	
3.5.6 Evaporation Rate	Gallons per minute	
3.5.7 Makeup Flow Rate	Gallons per minute	
3.5.8 Cooling Pond Temperature Range	°F	
3.5.9 Cooling Water Flow Rate	Gallons per minute	
3.5.10 Heat Rejection Rate (Blowdown)	Gallons per minute @ °F	
3.5.11 Maximum Consumption of Raw Water	Gallons per minute	
3.5.12 Monthly Average Consumption of Raw Water	Gallons per minute	
3.5.13 Stored Water Volume	Gallons	
4. Containment Heat Removal System (Post-Accident)		
4.1 Ambient Air Requirements		
4.1.1 Maximum Ambient Air Temperature (0% Exceedance)	°F	

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Parameter	Units	VALUE
4.1.2 Minimum Ambient Temperature (0% Exceedance)	°F	
5. <u>Potable Water/Sanitary Waste System</u>	REM	
5.1 Discharge to Site Water Bodies		
5.1.1 Flow Rate	Gallons per minute	
5.2 Raw Water Requirements		
5.2.1 Maximum Use	Gallons per minute	
5.2.2 Monthly Average Use	Gallons per minute	
6. <u>Demineralized Water System</u>		
6.1 Discharge to Site Water Bodies		
6.1.1 Flow Rate	Gallons per minute	
6.2 Raw Water Requirements		
6.2.1 Maximum Use	Gallons per minute	
6.2.2 Monthly Average Use	Gallons per minute	
7. <u>Fire Protection System</u>		
7.1 Raw Water Requirements		
7.1.1 Maximum Use	Gallons per minute	
7.1.2 Monthly Average Use	Gallons per minute	
7.1.3 Stored Water Volume	Gallons	
8. <u>Miscellaneous Drain</u>		
8.1 Discharge to Site Water Bodies		
8.1.1 Flow Rate	Gallons per minute	
9. <u>Unit Vent/Airborne Effluent Release Point</u>		
9.1 Atmospheric Dispersion (CHI/Q) (Accident)		
9.1.1 0-2 hr @ EAB	Seconds per meter cubed	
9.1.2 0-8 hr @ LPZ	Seconds per meter cubed	
9.1.3 8-24 hr @ LPZ	Seconds per meter cubed	

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Parameter	Units	VALUE
9.1.4 1-4 day @ LPZ	Seconds per meter cubed	
9.1.5 4-30 day @ LPZ	Seconds per meter cubed	
9.2 Atmospheric Dispersion (CHI/Q) (Annual Average)	Seconds per meter cubed	
9.3 Dose Consequences		
9.3.1 Normal	REM	
9.3.2 Post-Accident	REM	
9.3.3 Severe Accidents		
9.4 Release Point		
9.4.1 Configuration (Horiz vs Vert)	Horizontal or Vertical	
9.4.2 Elevation (Normal Operation)	Feet	
9.4.3 Elevation (Post Accident)	Feet	
9.4.4 Minimum Distance to Site Boundary	Feet	
9.4.5 Temperature	°F	
9.4.6 Volumetric Flow Rate	Standard Cubic Feet per Minute	
9.5 Source Term		
9.5.1 Gaseous (Normal)	Curies per year	
9.5.2 Gaseous (Post-Accident)	Curies	
9.5.3 Tritium	Curies per year	
10. Liquid Radwaste System		
10.1 Dose Consequences		
10.1.1 Normal	REM	
10.1.2 Post-Accident	REM	
10.2 Release Point		
10.2.1 Flow Rate	Gallons per minute	
10.3 Source Term		
10.3.1 Liquid	Curies per year	
10.3.2 Tritium	Curies per year	

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Parameter	Units	VALUE
11. Solid Radwaste System		
11.1 Acreage		
11.1.1 Low Level Radwaste Storage	Acres	
11.2 Solid Radwaste		
11.2.1 Activity	Curies per year	
11.2.2 Principal Radionuclides	Curies per year	
11.2.3 Volume	Cubic feet per year	
12. Spent Fuel Storage		
12.1 Spent Fuel Dry Storage		
12.1.1 Acreage	Acres	
12.1.2 Minimum Distance to Nearest Residence	Feet	
12.1.3 Minimum Distance to Power Block	Feet	
12.1.4 Storage Capacity	Years	
13. Auxiliary Boiler System		
13.1 Exhaust Elevation	Feet	
13.2 Flue Gas Effluents	Pounds per year	
13.3 Fuel Type	N/A	
13.4 Heat Input Rate	BTU per hour	
14. Heating, Ventilation and Air Conditioning System		
14.1 Ambient Air Requirements		
14.1.1 Non-safety HVAC max ambient temp (1% Exceedance)	°F	
14.1.2 Non-safety HVAC min ambient temp (1% Exceedance)	°F	
14.1.3 Safety HVAC max ambient temp (0% Exceedance)	°F	
14.1.4 Safety HVAC min ambient temp (0% Exceedance)	°F	
14.1.5 Vent System max ambient temp (5% Exceedance)	°F	
14.1.6 Vent System min ambient temp (5% Exceedance)	°F	

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Parameter	Units	VALUE
<u>15. Onsite/Offsite Electrical Power System</u>		
15.1 Acreage		
15.1.1 Switchyard	Acres	
<u>16. Standby Power System</u>		
16.1 Diesel		
16.1.1 Diesel Capacity	Kilowatts	
16.1.2 Diesel Exhaust Elevation	Feet	
16.1.3 Diesel Flue Gas Effluents	Pounds per year	
16.1.4 Diesel Noise	Decibels	
16.1.5 Diesel Fuel Type	N/A	
16.2 Gas-Turbine		
16.2.1 Gas-Turbine Capacity	Kilowatts	
16.2.2 Gas-Turbine Exhaust Elevation	Feet	
16.2.3 Gas-Turbine Flue Gas Effluents	Pounds per year	
16.2.4 Gas-Turbine Noise	Decibels	
16.2.5 Gas-Turbine Fuel Type	N/A	
<u>17. Plant Characteristics</u>		
17.1 Access Routes		
17.1.1 Heavy Haul Routes	Acres	
17.1.2 Spent Fuel Cask Weight	Tons	
17.2 Acreage		
17.2.1 Office Facilities	Acres	
17.2.2 Parking Lots	Acres	
17.2.3 Permanent Support Facilities	Acres	
17.2.4 Power Block	Acres	
17.2.5 Protected Area	Acres	
17.3 Megawatts Thermal	Mega-watts	
17.4 Plant Design Life	Years	
17.5 Plant Population		
17.5.1 Operation	Persons	

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Parameter	Units	VALUE
17.5.2 Refueling / Major Maintenance	Persons	
17.6 Station Capacity Factor	Percent	
18. Construction		
18.1 Access Routes		
18.1.1 Construction Module Dimensions	Feet	
18.1.2 Heaviest Construction Shipment	Tons	
18.2 Acreage		
18.2.1 Laydown Area	Acres	
18.2.2 Temporary Construction Facilities	Acres	
18.3 Construction		
18.3.1 Noise	Decibels	
18.4 Plant Population		
18.4.1 Construction	Persons	
18.5 Site Preparation Duration	Months	
19. Other – Identify any other site characteristic assumptions embedded in the anticipated design which needs to be verified that the site can accommodate – e.g. storage tanks, acreage needs, chemicals to be used by/transported to/from facility		

COMPLETED BY: _____

DATE: _____

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APPENDIX C

SITE CHARACTERISTIC EVALUATION TEMPLATES

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HEALTH AND SAFETY CHARACTERISTICS TEMPLATES

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HEALTH AND SAFETY CHARACTERISTICS TEMPLATES

GEOLOGY, SEISMOLOGY AND GEOTECHNICAL ENGINEERING

Seismic Ground Motions

Global Geohazards

Site Geotechnical

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FEASIBILITY PARAMETER: HEALTH AND SAFETY / GEOLOGY, SEISMOLOGY AND GEOTECHNICAL ENGINEERING / Seismic Ground Motions

PARAMETER DESCRIPTION: Seismic ground motion assessment involves evaluation of the level of earthquake-induced vibratory shaking based on analyses of regional and local faults, tectonic stress conditions and structures, historic and instrumental seismicity (past earthquake record), paleoseismic features (prehistoric, geologic evidence of past earthquakes), and site geologic/stratigraphic conditions (e.g., shear wave velocity profile). The level of seismic ground shaking at the site is estimated for a specific probability (hazard) level, defined by applicable regulatory criteria (e.g., annual probability of exceedance of 1×10^{-4}). The site-specific seismic ground shaking is typically summarized by a seismic design response spectrum that plots ground acceleration versus frequency of vibration. This response spectrum is compared against the Certified Seismic Design Response Spectrum (CSDRS) used for design of the power plant to ensure that site-specific earthquake ground motions are below the design level for safety-related structures, systems, and components (SSCs).

PARAMETER IMPORTANCE: General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that SSCs important to safety be designed to withstand the effects of natural phenomena such as earthquakes and geologic hazards, without loss of capability to perform their safety functions. Strong vibratory ground shaking, or possible ground failure triggered by seismic shaking, may pose an unacceptable risk to the continued operability of safety related (SR) SSCs. 10 CFR Part 100, Section 100.23, "Geologic and Seismic Siting Criteria" defines criteria for evaluating the suitability of a proposed site based on consideration of geologic, geotechnical, geophysical, and seismic characteristics. A Safe Shutdown Earthquake (SSE) is defined for evaluation of the possible level of ground shaking based on evaluation of potential earthquake sources, past documented earthquakes, and site characteristics. The SSCs must be able to remain functional under the site-specific SSE level of earthquake ground shaking.

Guidelines for development of the SSE are defined in Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion". Current industry practice, and updated NRC Regulatory Guides, have migrated away from the SSE approach defined in Regulatory Guide 1.165, and instead adopt a probabilistic, performance-based approach defined in Regulatory Guide 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion" for qualifying a SSE for a site. For

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application of the performance-based approach, a site-specific ground motion estimate defined as the “Ground Motion Response Spectrum” (GMRS) is determined, using essentially the same basic geologic, tectonic, seismicity, and site characteristics input that are used to develop the SSE as outlined in Regulatory Guide 1.165. The Standard Review Plan (NUREG-0800) provides insight as to areas of review by the NRC Staff, and indicates that either the Regulatory Guides 1.165 or 1.208 approaches to developing the SSE are suitable.

For site screening purposes, potential ground shaking levels are developed in an approach generally consistent with the SSE/GMRS methodology, with the level of consistency increasing with the more-focused later phases of screening. For the initial screening, a single estimate of site ground motion can be utilized (e.g., peak ground acceleration, PGA), and for preferred sites at the final screening stages a ground acceleration response spectrum can be used. The resulting PGA and response spectrum are compared against the seismic design basis, or Certified Seismic Design Response Spectrum (CSDRS), of the plant to demonstrate that the site-specific ground motion is enveloped by the plant design seismic levels.

PARAMETER RISK:

The NRC Staff will review the site-specific SSE/GMRS and the technical basis used (e.g., seismic source model and site characteristics) to determine the ability of the safety related SSCs to withstand the predicted levels of seismic shaking. The predicted site ground motions will also be evaluated to assess the likelihood of seismically-induced ground failure, as described in the “Geologic Hazard” and “Site Geotechnical” templates.

Regulatory Guide 1.60, “Design Response Spectra for Seismic Design of Nuclear Power Plants” defines a smooth response spectrum that is generally used as the basis for many of the current CSDRS’s accepted or under consideration by the NRC. For example, current standard nuclear plant designs for the Central and Eastern United States (CEUS) generally adopt the Regulatory Guide 1.60 spectrum anchored at a maximum PGA of 0.3g, with some modifications (especially in the high frequency range of the spectrum) to the base-line spectra by individual vendors. Available CSDRS’s, either developed generically or for specific sites, may accommodate greater seismic design levels, but higher design motions may be accompanied by a greater level of regulatory evaluation, higher licensing risk and duration, greater design costs, and greater construction costs. Therefore, the Regulatory Guide 1.60 spectral shape anchored at 0.3 g PGA is not strictly an exclusionary criteria. However, areas with ground motions that result in an exceedance of the Regulatory Guide 1.60 spectrum and PGA of 0.3 g are best initially avoided or down-ranked in an initial screening study. The likelihood of an

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exceedance of the Regulatory Guide 1.60 spectrum, and 0.3 g PGA, increases dramatically for highly seismic areas, and areas near potentially active geologic/tectonic structures.

The recommended siting approach is to initially avoid areas where regional hazard mapping shows PGA exceeding 0.30g at an annual probability of exceedance of 1×10^{-4} . This probability of exceedance, roughly correlative with a seismic event with recurrence intervals of about 10,000 years, enables screening to be performed using reasonably-available resources, such as the 2008 U.S. Geological Survey National Seismic Hazard Maps (Peterson et al., 2008) and the U.S. Geological Survey Quaternary Fault and Fold database (Machette, et. al., 2004).

EVALUATION:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION:

The plant safety related SSCs must be capable of withstanding the site-specific SSE/GMRS ground motions. If an existing probabilistic seismic hazard analysis (PSHA) model is being used in the screening, the technical basis and justification of the model must be evaluated; If a new PSHA is being developed, a technical basis for that model must be developed. The evaluation is commonly conducted by a team of geologists and seismologists experienced in all aspects of PSHA models (e.g., source characterization, ground motion attenuation, site response). This evaluation typically involves a review of the regional and local geologic setting, tectonic setting, and known seismic sources as reported within publicly available information (e.g., journal articles, government publications) and as discovered through interviews of the professional community (e.g., university researchers, U.S. Geological Survey researchers, consultant experts).

For existing PSHA models (e.g., the 2008 U.S. Geological Survey Seismic Hazard Maps), potential earthquake sources that are not included in the existing model (e.g., updated source information, newly-identified faults, etc.) need to be accounted for within the analysis of sites. For new PSHA models being developed, all potential earthquake sources capable of impacting the site need to be included following the guidance of Regulatory Guide 1.208. These PSHA models are then used to calculate the screening level site ground motions (e.g., PGA or response spectrum), and the ground motion levels for alternate sites are compared against the evaluation criteria listed above and the plant CSDRS to establish a relative ranking.

Unfavorable sites are dismissed or downgraded, with a brief summary of the basis for the initial ranking. Favorable sites are then described and verified by further more-detailed ground

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motion analyses in compliance with Regulatory Guide 1.165 or 1.208 procedures, and as described below.

Site Type – The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield “ or existing nuclear power plant site, in addition to site characteristics such as deep soil, dense shallow soil, or bedrock conditions. The evaluation should identify the unique applicability of site type-related differences, if any, for the treatment of this issue. For example, bedrock sites may be preferable to adjacent deep soil sites (that can amplify ground motions) for areas where controlling earthquakes are from distant, major sources with potentially large earthquakes. In contrast, some dense soil or soft rock sites may be preferable to hard rock sites in areas where controlling ground motions are related to nearby sources of small to moderate size earthquakes that can produce substantial high frequency motions. In addition, the evaluation should take into consideration existing data and analyses that might be available, for example, in the case of an existing nuclear site or, perhaps, a “Brownfield site.” In these cases the additional ground motion analysis may not be needed and the overall confidence level in the analysis results may be very high compared to a “Greenfield site.”

Evaluation criteria – A site is classified as “Acceptable Site” if site-specific ground motions are <90% of RG 1.60 spectra.

A site is classified as “Challenged Site Requiring Further Evaluation” if site-specific ground motions are = 90% to 110% of RG 1.60 spectra.

A site is classified as “Site Not Suitable” if site-specific ground motions are >110% of RG 1.60 spectra.

The Standard Review Plan (NUREG-0800) describes types of ground motion analyses acceptable to the NRC staff for safety related SSCs. It should be used in conjunction with the following acceptability guidance to determine final site acceptability. The site verification ground motion analysis should be performed for a probability of exceedance equivalent to 1×10^{-4} (roughly 10,000 year return period) to develop correlative site-specific SSE/GMRS ground motions correlative to the Regulatory Guide 1.60 spectrum. This requires collection of regional and site data including development of a documented seismic source model, site-specific Probabilistic Seismic Hazard Analyses (PSHA), and where warranted, a site response analyses that incorporates geotechnical subsurface exploration, and geophysical (e.g., shear wave velocity profiles) and laboratory test data (e.g., dynamic soil testing). The results from the site-specific verification analyses are again classified according to the Evaluation Criteria listed above. Those sites exhibiting site-specific ground motions 90% or less of the Regulatory Guide 1.60 spectrum anchored at 0.3 g are

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deemed to be Fully Acceptable. Those sites with site-specific ground motions between 90% and 110% of the Regulatory Guide 1.60 spectrum anchored at 0.3 g are considered Challenged and downranked. Any sites exhibiting site-specific ground motions in excess of 110% of the Regulatory Guide 1.60 spectrum anchored at 0.3 g should be further downranked, and/or considered to be Unfavorable/Potentially Not Suitable. More-detailed ground motion analyses are required to further evaluate/verify the suitability of sites classified as Challenged or Potentially Not Suitable.

Risk – A primary technical risk associated with site seismic evaluation is insufficient knowledge of potential earthquake sources and/or site conditions that could potentially cause under prediction of actual seismic ground motion levels for site screening. If site screening suggests seismic ground motions are acceptable, yet later detailed studies demonstrate that they are higher and exceed plant design criteria, a late-stage site rejection or potential forced plant seismic re-evaluation may be necessitated. Potential regulatory risks associated with seismic evaluation include extensive Requests for Additional Information (RAIs) and protracted review process if seismic sources and site conditions are not adequately investigated and documented. The degree of risk becomes lower as more information about possible earthquake sources and site conditions become available, or are directly developed. The degree of risk also is lower for sites that are not within, or near, known areas of active geologic processes such as active faults, volcanic centers, crustal plate margins, zones of enhanced historic seismicity, etc.

Risk Mitigation – The risk associated with under prediction and/or poor characterization of seismic conditions can be reduced by: (1) integration of experienced seismic experts in the site selection team; (2) collection and documentation of a robust data base of existing information and querying of topical and regional seismic experts; (3) use of conservative assumptions for initial ground motion modeling/analyses; (4) geologic aerial and field reconnaissance in the site region and location; (5) obtain site-specific geologic, geophysical, and geotechnical information to evaluate seismic site response, dynamic properties, and ground failure potential; and, (6) early NRC interaction.

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REFERENCES:

1. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants"
2. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion"
3. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion"
4. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.4.4, "Potential Dam Failures"
5. 2008 U.S. Geological Survey National Seismic Hazard Maps (Peterson et al., 2008)
6. U.S. Geological Survey Quaternary Fault and Fold database (Machette, et. al., 2004)

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FEASIBILITY PARAMETER: HEALTH AND SAFETY / GEOLOGY, SEISMOLOGY AND GEOTECHNICAL ENGINEERING / Global Geohazards

PARAMETER DESCRIPTION: Global Geohazard (including “Surface Deformation” commonly referenced in NRC Regulatory Guides) assessment involves evaluation of the potential for surface deformation at, or through, the plant site as the result of active geologic processes including fault displacement, tectonic deformation, subsidence (typically induced by groundwater withdrawal or mining), karst/dissolution, mechanically weakened zones (shear zones), liquefaction, irregular weathering, slope failure (landslides), unstable geologic deposits, and volcanism. The geohazard potential is assessed by compilation and review of existing geoscience data and remote imagery, followed by geologic reconnaissance (ground and aerial) and site subsurface exploration. Typically, the risk and hazard assessment associated with geohazards is performed on a qualitative basis in the initial siting phase, with possible quantitative evaluation of identified geohazards during later “fatal flaw” site verification. With regards to geologic processes, those structures or phenomena that show evidence of activity within the Quaternary geologic period (past 1.8 million years) are considered to be potentially active structures that require additional investigation. The NRC formally defines capable structures as those with evidence of activity once in the past 50,000 years or with evidence of recurring activity within the past 500,000 years (Regulatory Guide 1.208). The typical approach with regards to geohazards is avoidance, rather than mitigation. Avoidance is preferred because many geohazards cannot be reasonably mitigated (e.g., active fault displacement), would require prohibitive characterization/mitigation costs, and pose a major licensing risk due to potential license rejection and an extended review schedule.

Appendix D to Regulatory Guide 1.165 (D.2.1) states that: (1) in general, any tectonic surface deformation within 25 miles (40 km) of a site will require detailed investigation to determine its significance, (2) engineering solutions may not be adequate to mitigate the effects of ground surface deformation or displacement, and (3) it is prudent to select an alternative site when a potential for permanent ground displacement exists at a proposed site. Therefore, site locations that are within 25 miles (40 km) of a tectonic structure that has exhibited, or has the potential to exhibit, surface displacement or deformation should be avoided, if possible, or downranked in comparison to other sites. If such a site is considered, it must be determined, through detailed investigations, whether the structure is capable. If the investigations demonstrate that the structure is not capable, then additional considerations relative to surface displacement or deformation would not be required. Section D.2.1 also indicates

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that more extensive investigation will be needed for any faults or other tectonic structures located within 5 miles (8 km) of a site to determine if they are capable tectonic sources. Accordingly, sites without such structures are more favorable.

PARAMETER IMPORTANCE:

General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that structures, systems, and components (SSCs) important to safety be designed to withstand the effects of natural phenomena such as earthquakes and geologic hazards, without loss of capability to perform their safety functions. Geohazard-related surface deformation or movements can pose an unacceptable risk to the continued operability of safety related SSCs. 10 CFR Part 100, Section 100.23, "Geologic and Seismic Siting Criteria" defines criteria for evaluating the suitability of a proposed site based on consideration of geologic, geotechnical, geophysical, and seismic characteristics of the proposed site. The presence of geohazards or Quaternary-active geologic structures, are identified and compiled on regional and local maps typically in a Geographic Information System (GIS) database. Particular focus is given to any geohazards or Quaternary structures within each of three areas defined by circles drawn around the site using radii of 25 miles (40 km), 5 miles (8 km), and 0.6 miles (1 km).

Guidelines for evaluation of geohazards (surface deformation) are presented in Regulatory Guides 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion", and 1.208 "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion". Some additional guidance related to characterization of geohazards and potential adverse site conditions is provided in Regulatory Guides 1.132 "Site Investigations for Foundations of Nuclear Power Plants", 1.198 "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites", and 4.7 "General Site Suitability Criteria for Nuclear Power Stations".

The Standard Review Plan (NUREG-0800) provides insight as to areas of review by the NRC Staff, and references the above-listed Regulatory Guides as guiding criteria. The Standard Review Plan specifies compliance with requirements of 10 CFR 100.23 with respect to evaluation of geohazards (surface deformation).

For site screening purposes, potential geohazards are identified and compiled on regional and local maps in a consistent approach as specified in Regulatory Guides 1.165 and 1.208, including, as appropriate, GIS-based maps of the 25 miles (40 km), 5 miles (8 km), and 0.6 miles (1 km) radii around the site. The geohazard

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map compilation is performed in a consistent manner for all considered sites to permit relative evaluation and ranking of sites. For identified and mapped geohazards, brief descriptive narratives are developed that summarize the hazard/feature, define its characteristics and potential hazard, and describe potential additional work for further characterization, if needed, during later "fatal flaw" verification studies.

PARAMETER RISK:

The NRC Staff will review the possible presence of geohazards (surface deformation), as described above, to determine the potential risk for the safe function of the safety related SSCs. Regulatory documents do not define exclusionary criteria for geohazards/surface deformation, but rather suggest avoidance and detailed characterization of potential geohazards and Quaternary geologic structures. Nuclear plant Design Control Documents (DCD) provide performance criteria with respect to plant foundation stability and settlement that can be used to compare against estimated magnitudes of surface deformation associated with a geohazard. However, characterization of potential magnitudes of surface deformation associated with a geohazard typically has substantial uncertainty, and/or requires very extensive, expensive, and long-duration field and office studies. Additionally, regulatory review schedules may be significantly extended if geohazard characterization and mitigation is required, and final regulatory acceptance of the site may be jeopardized. For example, it is stated in the Standard Review Plan that "It is important to note that no commercial nuclear power plant has ever been constructed on a known capable tectonic deformation feature, and it is questionable whether it may be feasible to design for surface or near-surface tectonic displacements with any degree of confidence that safety-related plant features would remain intact and functional if displacements were to occur. Consequently, it is NRC policy to recommend that any site determined, based on results of detailed fault investigations, to lie on a surface or near-surface tectonic structure capable of displacement be prudently re-located to an alternate site by the applicant."

Therefore the recommended siting approach is to avoid areas where regional and local mapping show the presence of geohazards and Quaternary geologic structures. For initial screening, consistent setback distances from various types of possible geohazard or Quaternary geologic structures (e.g., active faults, volcanic centers, areas of subsidence, etc.) are established and used to develop derivative hazard maps defining hazard avoidance zones. A ranking matrix is developed that includes relative hazard for various identified or mapped geohazards (i.e. some geohazards are more "hazardous" than others), setback distance, and activity. Various published maps and databases,

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such as the 2004 Quaternary Fault and Fold database (Machette, et. al., 2004), provide consistent and appropriately detailed information for regional screening purposes of large areas 25 miles (40 km) radius), and for identification of major Quaternary geologic/tectonic structures. State geological surveys and Federal agencies typically publish maps at various levels of detail and scales (e.g., 25 to 5 miles (40 to 8 km) radii) that are useful to define general geologic setting and stratigraphy, mining and natural resources, hazards (e.g., landslide maps, volcanic hazard maps), and soil types (e.g., Soil Conservation Service) that help identify and define potential geohazards or sources of surface deformation. Local agencies (e.g., Regional Water Quality Control Boards, County Building Departments) typically compile maps and databases at local and detailed scales that are useful for evaluation of conditions and features within the 5 miles (8 km) and 0.6 miles (1 km) site radii. These local maps and databases are especially useful to evaluate potential hazards related to man-induced subsidence related to groundwater withdrawal, mining, or oil and gas production. These various maps, augmented with remote imagery interpretation (e.g., satellite, air photographs), and discussions with local geosciences researchers, provide initial information for site-specific screening. Any data from previous geologic, geophysical, groundwater, and geotechnical studies performed at the site(s) greatly assist site-specific evaluation of potential geohazards (surface deformation), and should be collected, if available. Existing nuclear plant sites typically have the greatest amount of, and best quality, site-specific data, followed by "Brownfield" sites that have had previous large structures or facilities. If existing site-specific and subsurface data is not available (e.g., "Greenfield" site), then limited "fatal flaw" site investigations may be required for final verification of alternative sites.

EVALUATION:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION:

The plant safety related SSCs must be capable of withstanding potential surface deformations at the site related to geohazards. The evaluator is expected to identify any potential geohazards or causes of surface deformation, and assess the potential hazard/risk associated with identified features. Initial screening is performed using existing geosciences databases, as described above, and regional reconnaissance by plane and or driving surveys. Initial screening of alternative sites is performed using the distance-based Evaluation Criteria listed above.

Unfavorable sites are downranked, or dismissed (if other clearly more-favorable sites are identified), with a brief summary of the

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basis for this initial ranking. Favorable and Challenged sites are then ranked and described. Those sites found to be most-favorable are verified by further more-detailed evaluation in compliance with Regulatory Guide 1.165 or 1.208 procedures, and as described below.

For initially Favorable, and possibly Challenged, sites an additional level of screening is performed to refine a relative ranking scheme that incorporates criterion such as distances to geohazards, activity of features, and potential magnitude or style of deformation. The additional screening incorporates more detailed, and larger scale, map data from state and local agencies, review of satellite and aerial photograph imagery, site reconnaissance visits, and compilation/review of any available site-specific geologic, geophysical, geotechnical, and groundwater data and investigations. This information is compiled within a GIS database and analyzed in conformance with guidelines presented in Regulatory Guides 1.165 and 1.208. The additional information is used to develop, or refine, recommended setback distances from identified geohazards and Quaternary geologic features, and to estimate relative activity and surface deformation hazard.

Those sites that are advanced as preferred sites are verified by site-specific “fatal flaw” investigations that may include geologic mapping, subsurface exploration, geophysical and laboratory testing, as well as geologic and geotechnical engineering analyses. These site-specific investigations should be performed in compliance with guidelines presented in Regulatory Guides 1.165, 1.208, 1.132, and 1.138.

The results from the final ranking and/or fatal flaw verification studies are used to document an absence of potential geohazards/surface deformation at the site(s), or provide convincing initial investigative and quantitative data and analyses to demonstrate that potential surface deformations are less than the plant DCD and/or performance criteria.

Site Type – The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield “ or existing nuclear power plant site. The evaluation should identify the unique applicability of site type-related differences, if any, for the treatment of this issue. In addition, the evaluation should take into consideration existing data and analyses that might be available, for example, in the case of an existing nuclear site or, perhaps, a “Brownfield site.” In these cases the “fatal flaw” site investigations may not be needed and the overall confidence level in the analysis results may be very high compared to a “Greenfield site.”

Evaluation criteria – A site is classified as “Acceptable” if no identified or suspected geohazards are within 25 miles (40 km) of the site.

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A site is classified as "Challenged Site Requiring Further Evaluation" if there are identified or suspected geohazards between 5 and 25 miles (8 and 40 km) of the site.

A site is classified as "Site Not Suitable" if any geohazards are identified onsite or within a 5-mile (8-km) radius of the site.

The Standard Review Plan (NUREG-0800) describes the expected data sources and level of investigation and evaluation for screening of geohazards that are acceptable to the NRC staff for SR SSCs. As described previously, NRC indicates a preference for avoidance of geohazards/surface deformation rather than mitigation. A significant licensing risk is taken on for any sites that are potentially impacted by geohazards/surface deformation, even if detailed investigations and analyses demonstrate that potential magnitudes of deformation are within allowable tolerances specified in the plant DCD. The NRC references procedures and approaches presented in Regulatory Guides 1.165, 1.208, 1.132, and 1.138 to determine final site acceptability.

Those sites with no identified or suspected geohazards or surface deformation sources within 25 miles (40 km) are deemed to be Fully Acceptable. Those sites with identified or suspected geohazards or deformation sources at distances of between 5 and 25 miles (8 and 40 km) of site should be downranked. Sites with geohazards or surface deformation sources identified on, or within 5 miles (8 km) radius of site should be further downranked, and/or considered to be Unfavorable/Potentially Not Suitable. More-detailed site studies are required to further evaluate/verify the suitability of sites classified as Challenged or Potentially Not Suitable.

Risk – A primary technical risk associated with site global geohazard evaluation is insufficient knowledge of potential geohazard and surface deformation sources that could potentially exist at, or near, the site(s). Insufficient knowledge could result in non-identification, misrepresentation of geohazards feature/structure activity, under prediction of potential surface deformation magnitude, etc. If site screening suggests that no significant geohazards or surface deformation sources exist or represent potential hazard, yet later detailed studies show that a hazard exists, a late-stage site rejection or potential major mitigation and investigative delays may be incurred. Potential regulatory risks associated with geohazard evaluation include extensive Requests for Additional Information (RAIs) and expectations for comprehensive site and regional geologic/geotechnical study, and associated protracted review process or possible non-acceptance by NRC. The degree of risk becomes lower as more information about possible earthquake

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sources and site conditions become available, or are directly developed. The degree of risk also is lower for sites that are not within, or near, known areas of active geologic processes such as active faults, volcanic centers, crustal plate margins, zones of enhanced historic seismicity, etc.

Risk Mitigation – The risk associated with under prediction and/or poor characterization of geohazards and surface deformation can be reduced by: (1) integration of experienced geologic experts in the site selection team; (2) collection and documentation of a robust data base of existing information and querying of topical and regional experts; (3) use of conservative assumptions regarding activity and consequences for initial evaluations of potential geohazard/surface deformation sources; (4) geologic aerial and field reconnaissance in the site region and location; (5) obtain site-specific geologic, geophysical, and geotechnical information to evaluate site geologic conditions and subsurface conditions; and; (6) early NRC interaction.

REFERENCES:

1. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion"
2. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.208, "A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion"
3. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants"
4. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.138, "Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants"
5. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites"
6. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.4.4, "Potential Dam Failures"
7. U.S. Geological Survey Quaternary Fault and Fold database (Machette, et. al., 2004)

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FEASIBILITY PARAMETER: HEALTH AND SAFETY / GEOLOGY, SEISMOLOGY AND GEOTECHNICAL ENGINEERING / Site Geotechnical

PARAMETER DESCRIPTION: Site Geotechnical (stability of subsurface conditions and foundations) assessment involves evaluation of the potential for site-specific geologic and geotechnical hazards or issues that could affect plant safety or function, or present unusual difficulty or cost for construction of a plant at the site. Specific issues/conditions that fall under this category, as defined in the Standard Review Plan (SRP) include subsidence, karst/dissolution, uplift/heave (stress relief), collapse/settlement, localized altered or weak zones, irregular weathering profiles, weak bedrock structures or shear zones, unstable mineralogy, seismically-induced ground failure (e.g., liquefaction, lateral spreading), soil amplification of seismic ground motions, and high or unusual groundwater conditions. Evaluation of these issues requires characterization of the site-specific geologic and soil stratigraphy and composition, geologic structure and stress history (e.g., past glacial loading, erosional stress relief, tectonic stress), subsurface material engineering properties (e.g., shear strength, density, compressibility, stress-relief or saturation-induced weakening), groundwater conditions, and impacts of site construction activities (e.g., fill and foundation surcharge loading, excavation-induced stress relief). Initial evaluation of site geotechnical conditions is performed by compilation and review of existing geoscience data and remote imagery to understand the geologic setting and depositional/stress history, followed by geologic reconnaissance (ground and aerial) and site subsurface exploration and material testing. Typically, assessment of the risks and hazards associated with site geotechnical conditions is performed on a qualitative basis in the initial siting phase, with follow-on quantitative evaluation during “fatal flaw” site verification. The quantitative evaluation is initially performed using any available existing data compiled from local agencies and the applicant (e.g., existing plant Safety Analysis Report or “Brownfield” site geotechnical studies), and limited field reconnaissance mapping and inspection. Fatal flaw verification investigations typically are required for most sites, even those with existing site-specific investigation data, in order to obtain consistent information for each site to enable final suitability ranking and site selection. The site geotechnical assessment is performed concurrently with the geohazards/surface deformation evaluation to ensure consistent hazard evaluations between different site parameters. Site geotechnical evaluation typically is a focal point for NRC review, and insufficient characterization of site conditions and related potential issues at the siting stage can lead to delays in the NRC acceptance of a site.

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The typical approach with regards to adverse site geotechnical issues is avoidance, where possible. However, as opposed to other geologic and seismologic hazards (e.g., vibratory ground motions and permanent ground deformation), many geotechnical issues can be mitigated using industry standard approaches to site preparation, ground improvement, and foundation design. Typical mitigation approaches include: ground improvement through grouting or other techniques (e.g. for mitigation of shallow liquefaction or weak soils), deepening of foundations, groundwater pumping or control, and grading overexcavation (removal of weak or unsuitable surface soils or weathered zones). Therefore, geotechnical issues typically are not considered exclusionary criteria, but rather are considered as avoidance or preference criteria when comparing alternative sites. Mitigation measures, if proposed, must consider the specific foundation performance criteria for the plant defined in the Design Control Document (DCD) and increased investigative and cost impacts in comparison to less-challenged sites. This is accomplished by developing a consistent ranking matrix that factors the potential impacts of mitigation.

PARAMETER IMPORTANCE: General Design Criterion 2, “Design Bases for Protection Against Natural Phenomena,” of Appendix A, “General Design Criteria for Nuclear Power Plants,” to 10 CFR Part 50, “Licensing of Production and Utilization Facilities,” requires that structures, systems, and components important to safety be designed to withstand the effects of natural phenomena such as earthquakes and geologic hazards (including adverse site subsurface or geotechnical conditions), without loss of capability to perform their safety functions. Unstable soil/rock, or adverse geologic/geotechnical/groundwater conditions may pose an unacceptable risk to the continued operability of safety related (SR) SSCs. 10 CFR Part 100, Section 100.23, “Geologic and Seismic Siting Criteria” defines criteria for evaluating the suitability of a proposed site based on consideration of geologic, geotechnical, geophysical, and seismic characteristics of the proposed site. Section 2.5.4 of NUREG-0800 presents the NRC’s Standard Review Plan (SRP) for the evaluation of site investigations used to determine soil and rock properties and characteristics needed in the analysis and design of foundations and earthworks for proposed nuclear power plants. Required investigations include dynamic and static analyses to evaluate the subsurface material’s responses to seismic loading, interactions between soils and structures, as well as foundation and facility stability.

Guidelines for the evaluation of site geotechnical conditions to ensure meeting the SRP and the requirements of 10 CFR Part 50 and 10 CFR Part 100, Section 100.23 are presented in Regulatory

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Guides 1.132 “Site Investigations for Foundations of Nuclear Power Plants”, 1.138 “Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants”, 1.198 “Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites”, and 4.7 “General Site Suitability Criteria for Nuclear Power Stations”.

As outlined in these regulatory guides, characterization of site geotechnical conditions and subsurface variability for design-level studies requires extensive subsurface investigations and testing. This level of effort is not feasible for initial siting studies. Therefore, for site screening purposes, potential site geotechnical hazards are initially assessed based on review of existing regional and local maps in a consistent approach as specified in Regulatory Guides 1.165 and 1.208, including, as appropriate, GIS-based maps of the 25 miles (40 km), 5 miles (8 km), and 0.6 miles (1 km) radii around the site. These maps are used to identify the general geologic setting, geologic formations and stratigraphy, stress history, and possible global geohazards (e.g., large-scale landsliding, young Quaternary geologic deposits potentially susceptible to liquefaction, active tectonic zones, evidence for past glaciation, etc.). Large-scale state or local geologic and geotechnical hazard maps, if available, can also provide useful information to evaluate potential major geotechnical hazards or issues. In addition to utilizing existing mapping, remote sensing techniques (e.g., analysis of Google Earth imagery and aerial photographs), coupled with direct aerial and/or ground reconnaissance, provide the primary means during initial screening studies to identify potential geotechnical hazards or issues. For identified geotechnical hazards or issues, brief descriptive narratives are developed that summarize the hazard/issue, define its potential impacts, and describe potential additional work for further characterization, if needed, during later “fatal flaw” verification studies.

PARAMETER RISK:

The NRC Staff will review the possible presence of adverse geotechnical conditions to determine the potential risk they present to the safe functioning of SSCs. Regulatory documents do not define exclusionary criteria for geotechnical issues but rather suggest avoidance coupled with detailed characterization of site geotechnical conditions, subsurface material properties, and their variability. The site characteristics and material properties are compared against the nuclear plant Design Control Documents (DCD) performance criteria for site characteristics to verify site suitability with respect to plant performance, such as foundation stability and tolerable settlements. The site geotechnical conditions also are assessed to verify that construction of the plant can be reasonably performed, and to define general mitigation approaches to address any geotechnical issues that cannot be

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reasonably avoided. The detailed site characterizations are needed either as evidence against the presence of adverse geotechnical conditions that require mitigation or as evidence supporting the techniques proposed to mitigate adverse geotechnical conditions.

In order to facilitate consistent factoring of geotechnical conditions between sites, a ranking matrix is developed that defines key potential geotechnical hazards (e.g., liquefaction susceptibility, landslide/slope failure susceptibility, karst/dissolution, subsidence) and primary geotechnical conditions that impact foundation design or site construction (e.g., soil type and thickness, depth to bedrock, shear wave velocity, groundwater conditions) that could have the greatest impact on construction schedule and cost for a site.

Any data from previous geologic, geophysical, groundwater, and geotechnical studies performed at the site(s) greatly assist site-specific evaluation of these potential hazards, and should be compiled, if available. Existing nuclear plant sites typically have the greatest amount of, and best quality, site-specific data, followed by “Brownfield” sites that have had previous large structures or facilities. If existing site-specific and subsurface data is not available (e.g., “Greenfield” site), then focused “fatal flaw” site investigations may be required for final verification of alternative sites.

EVALUATION:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION:

The plant SSCs must be capable of withstanding potential site geotechnical hazards and conditions without impact on safe function. This may be achieved by avoidance, or reasonable mitigation. The evaluator is expected to identify any potential geotechnical hazards, and provide a general characterization of primary geotechnical and subsurface conditions, to assess the potential hazard/risk and required mitigation efforts.

A first level of screening is performed using existing geoscience databases, as described above, and site reconnaissance by aerial and/or ground reconnaissance. Initial screening of alternative sites is performed using the distance-based Evaluation Criteria listed above. Unsuitable sites are dismissed, with a brief summary of the basis for dismissal. Favorable sites are described and verified by further more-detailed evaluation in compliance with Regulatory Guides 1.132, and 1.138, and 1.198 procedures, and as described below.

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The remaining sites undergo a secondary screening to define a relative ranking scheme that incorporates criterion such as distances to geohazards, activity of features, and potential magnitude or style of deformation. The secondary screening utilizes more detailed mapping from state and local agencies, more detailed reviews of satellite and aerial photograph imagery, additional site reconnaissance, and compilation/review of any available site-specific geologic, geophysical, geotechnical, and groundwater data from previous investigations. This information is compiled and analyzed in conformance with guidelines presented in Regulatory Guides 1.165 and 1.208, and compiled in a GIS database. Guidance within Regulatory Guides 1.132, 1.138, and 1.198 is used to assess the general quality and suitability of the available existing site-specific data. Combined, the results of these efforts are used to develop the comparative geotechnical hazard ranking matrix.

The geotechnical characteristics of those sites advanced as preferred sites by the site selection team are verified by site-specific “fatal flaw” investigations that may include geologic mapping, subsurface exploration, geophysical/laboratory testing, as well as geologic and geotechnical engineering analyses. These site-specific investigations should be performed in compliance with guidelines presented in Regulatory Guides 1.165, 1.208, 1.132, and 1.138.

The results from these studies will be used to either: (a) document the absence of primary geotechnical hazards at the site(s), (b) provide evidence demonstrating that geotechnical conditions at the site are within the plant DCD performance or can be reasonably mitigated for plant foundation design and site construction, or (c) result in a revision of the initial classification of a site as unsuitable. Based on these results a refined ranking for the site(s) can be developed.

Site Type – The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield” or existing nuclear power plant site. The evaluation should identify the unique applicability of site type-related differences, if any, for the treatment of this issue. In addition, the evaluation should take into consideration existing data and analyses that might be available, for example, in the case of an existing nuclear site or, perhaps, a “Brownfield site.” In these cases the “fatal flaw” site investigations may not be needed and the overall confidence level in the analysis results may be very high compared to a “Greenfield site.”

Evaluation criteria – A site is classified as “Acceptable” if there are generally favorable site conditions and no identified major geotechnical hazards.

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A site is classified as "Challenged Site Requiring Further Evaluation" if potential geotechnical hazards exist that can be reasonably mitigated and/or if some site improvement or special foundation approaches might be required.

A site is classified as "Site Not Suitable" if major or multiple geotechnical hazards exist or if highly adverse site conditions exist.

The Standard Review Plan (NUREG-0800) describes the expected data sources and level of investigation and evaluation for screening of site geotechnical conditions that are acceptable to the NRC staff for safety related SSCs. As described previously, NRC guidance indicates a preference towards avoidance of geotechnical issues rather than mitigation, and they have specific requirements and expectations regarding the approaches and level of site investigation and testing needed to characterize geotechnical conditions and variability. A significant licensing risk is taken on for any sites that are potentially impacted by major geotechnical hazards or that have multiple geotechnical issues requiring substantial mitigation. The NRC references procedures and approaches presented in Regulatory Guides 1.165, 1.208, 1.132, and 1.138 to determine final site acceptability.

Those sites with no identified or suspected major geotechnical hazards and generally favorable site conditions are deemed to be Fully Acceptable. Those sites with potential geotechnical hazards that can be reasonably mitigated and/or some site improvement or special foundation approaches possibly required should be classified as Challenged and initially downranked. Sites with major or multiple geotechnical hazards, or highly adverse site conditions should be classified as Unfavorable/Potentially Unsuitable and further downranked or dismissed. Sites that are classified as Challenged or Unfavorable/Potentially Not Suitable, yet still carried forward as possible sites, require further evaluation/verification to confirm their suitability, and reasonableness of required mitigation measures.

Risk – A primary technical risk associated with site geotechnical characterization is insufficient knowledge of potential geotechnical issues and hazards that could potentially exist at the site(s) and impact site foundation and grading design, or require extensive mitigation. Insufficient knowledge could result in non-identification or under prediction of potential severity of geotechnical issues. If site screening suggests that no significant geotechnical issues exist, yet later detailed studies reveal major geotechnical issues, late-stage redesign or major mitigation and investigative delays may be incurred. Potential regulatory risks associated with geotechnical site characterization include extensive Requests for Additional Information (RAIs) and expectations for comprehensive

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site and regional geologic/geotechnical study, and associated protracted review process or possible non-acceptance by NRC. The degree of risk becomes lower as more information about specific site conditions become available, or are directly developed. The degree of risk also is lower for sites that are not within known areas of geotechnical problems, have a high site uniformity, and have existing subsurface and geotechnical information.

Risk Mitigation – The risk associated with geotechnical characterization can be reduced by: (1) integration of experienced geologic/geotechnical experts in the site selection team; (2) collection and documentation of a robust data base of existing information and querying of topical and regional experts; (3) use of conservative assumptions regarding site conditions, uniformity, and material properties; (4) geologic aerial and field reconnaissance in the site region and location; (5) site-specific geologic, geophysical, and geotechnical information; (6) review and incorporation of “lessons learned” from past nuclear project siting and evaluation studies and existing license applications; and; (6) early NRC interaction.

REFERENCES:

1. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.165, “Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion”
2. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.208, “A Performance-Based Approach to Define Site-Specific Earthquake Ground Motion”
3. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.132, “Site Investigations for Foundations of Nuclear Power Plants”
4. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.138, “Laboratory Investigations of Soils and Rocks for Engineering Analysis and Design of Nuclear Power Plants”
5. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.198, “Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites”
6. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.4.4, “Potential Dam Failures”
7. U.S. Geological Survey Quaternary Fault and Fold database (Machette, et. al., 2004)

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HEALTH AND SAFETY CHARACTERISTICS TEMPLATES

HYDROLOGY

Water Availability

Flooding

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SITE CHARACTERISTIC: HEALTH AND SAFETY / HYDROLOGY / Water Availability

DESCRIPTION: 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, water use plans of cognizant water resource planning agencies, and other statutory requirements and policies govern the use and consumption of water at potential sites for normal operation.

IMPORTANCE: Depending on plant design, nuclear power plants may require reliable water sources for heat exchanger circulation and steam generation, emergency cooling, fire protection, potable water, and other functions.

RISK: The NRC Staff will compare the site water supply characteristics during times of low-flow and corrected for other use allocations as projected into the period of facility operations with the design basis facility water consumption rate. Water use and consumption must be compatible with existing water use plans. In the absence of an existing water use plan, the effect of plant water usage 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. The risk of insufficient quality or quantity of data may result in the rejection of the site for the nuclear power plant application.

- EVALUATION:**
- Acceptable Site**
 - Challenged Site Requiring Further Evaluation**
 - Site Not Suitable**

DISCUSSION:

Site Type - The analysis of water availability is relatively independent of site type (Greenfield, Brownfield, or existing nuclear power plant). Potential sites located in "greenfields" may require more investigation to characterize water sources while existing power plant sites and "brownfields" may possess extensive data. The intensity of each assessment will vary depending upon the quantity and quality of readily available data from existing plant sources and publicly available sources.

Evaluation Criteria - An Acceptable Site for the feasibility study is one that has adequate water resources to meet or exceed plant usage expectations during low-flow conditions and based on conservative assumptions without exceeding existing water withdrawal restrictions or affecting the ability of other water users to meet their water needs.

A Challenged Site (Requiring Further Evaluation) is one in which alternative water use strategies or mitigation measures would be necessary to meet water availability requirements for all users.

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A Site Not Suitable evaluation occurs when the capacity of available water resources is exceeded and it is not reasonable to mitigate impacts.

Water Availability During Low-Flow Conditions:

The high-level water availability analysis requires comparison between the low-flow site conditions or low water levels with the maximum rate of raw water use. 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. The frequency and duration of low-flow or low level periods should be determined from available historical records.

The limiting facility parameter requirements should be compared with candidate site water supply characteristics during low-flow conditions and projected use allocations over the life of the site (up to 65 years). For water supplies from rivers and streams, states typically disallow withdrawals exceeding 10 percent of the dependable flow to be withdrawn for consumptive use. The US Geological Survey (USGS) provides data on the 7-day average low-flow for a recurrence interval of 10 years (7Q10) for streams and rivers throughout the United States. 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.

The site is not suitable when rivers and stream segments indicate a minimum flow of record of less than the total of the facility consumption rate and the future non-facility consumption rate. The site is also not suitable when segments of streams or rivers that meet the criteria are located beyond realistic pumping distances that exceed engineering and cost criteria.

For lakes, the supply capacity would be evaluated considering the lake capacity and lake levels, as well as historic low levels (droughts) and refill (inflow) rates, together with the potential for conflict with lake usage, such as recreation.

It is assumed that an adequate water supply can be provided at estuarine and ocean sites with similar pumping distance constraints.

Groundwater supply sources can be included in the evaluation as independent sources or as supplemental sources to the surface water supply using the same conservative approach applied for projections of non-facility consumptive use. The groundwater supply can be estimated based on the aquifer yield characteristics and bounded by the aquifer areal distribution plus reasonable pumping distances.

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The water supply, whether the source is surface water, groundwater, or a combination of both, must meet the facility consumption rate combined with the projected future non-facility consumptive uses for the site to be acceptable.

Local, state, or regional water policies may also apply to the consumption of water. A demonstration of a request for certification of the rights to withdraw or consume water in a manner consistent with existing programs and policies may be included as part of the construction permit application or operating license application. Regulatory agencies should be consulted to determine applicable policies and avoid potential conflicts.

Impacts of Plant Water Usage:

Consumptive use of water 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. The allowance for non-facility future allocations (other users) should be based on conservative assumptions developed in consultation with state water supply planning.

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 Aquatic Ecology) or be inconsistent with the management goals for the water body. Similarly, plant withdrawals from multi-purpose rivers and streams may be restricted after assessing impacts to the flow of the river, important habitats, and the management goals for the water body.

The site evaluation relates to the degree with which the supply at low-flow conditions, based on 7Q10 and historical drought stages or water surface elevations, exceeds the design basis consumption rate and the projected future use requirements. Plant water usage may have a greater impact on water quality at sites with more limited water availability. The potential effects of cooling water withdrawals on water quality will be evaluated on the basis of the likelihood of conflicts, based on minimum flow availability, in areas with existing or expected wastewater discharges or other potentially significant water quality constraints.

Risk - Specific information about the site in question may not be available, but high quality data from publicly available local, state, and federal sources may be used to initially assess the site. Insufficient quality or quantity of data may result in increased investments of time and money to generate the data or in the rejection of the site for the nuclear power plant application.

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Risk Mitigation - Alternative water use strategies may be necessary to supplement available water sources to reduce the affect of low-flow conditions or low water levels on plant operation. Where water availability is low, construction of ponds and/or impoundments may be feasible.

REFERENCES:

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."
2. 10 CFR Part 100, "Reactor Site Criteria."
3. U.S. Nuclear Regulatory Commission, "Design Basis Floods for Nuclear Power Plants," "Regulatory Guide 1.59, Revision 2, August 1977."¹
4. U.S. Nuclear Regulatory Commission, "Ultimate Heat Sink for Nuclear Power Plants," Regulatory Guide 1.27, Revision 2, January 1976.
5. U.S. Nuclear Regulatory Commission, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, Regulatory Guide 1.70," Revision 3, November 1978.
6. U.S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," Revision 2, April 1998.

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SITE CHARACTERISTIC: HEALTH AND SAFETY / HYDROLOGY / Flooding

DESCRIPTION: Safety-related structures, systems, and components for a new candidate nuclear power plant site (Facility) would be designed to withstand the worst flooding caused by an appropriate combination of several hypothetical events. The Nuclear Regulatory Commission (NRC) requires the Facility to have applied for an application which will include evaluation of hypothetical worst case flooding scenarios. The hypothetical events include but are not limited to probable maximum flood (PMF), coincident wind-generated waves, probable maximum hurricanes, probable maximum tsunamis, surge, seiche, seismic failure of upstream and downstream dams, and ice jams etc. The potential for flooding at the Facility may involve any or all of the hypothetical events, or any various combinations of these events; such that the surface water level rises to or above the grade elevation of the Facility safety related structures.

IMPORTANCE: Nuclear Power Plants shall be designed to prevent the loss of capability for cold shutdown and maintenance resulting from the most severe flood conditions that may occur at a site due to hydrometeorological and seismic activities. General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," states that the structures, systems, and components important to safety be designed to withstand the effects of flooding due to combination of several hypothetical events discussed above without loss of capability to perform their safety functions. Flooding of the Facility may pose an unacceptable risk to the continued operability of safety related structures.

RISK: The NRC Staff will review the site elevation, plant layout and design, data, analyses and all flood-related factors, including those listed above, to determine the ability of the Facility to withstand the worst-case flooding scenarios and combinations thereof. The inability to demonstrate sufficient flooding protection may result in the rejection of the Facility for the nuclear plant application.

EVALUATION:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION: The Facility must be capable of withstanding the worst-case flooding either by showing that the site is a "Dry Site" (e.g., either as a result of natural terrain or by construction using engineered fill (i.e., "plant island") or through the use of external or incorporated barriers. The evaluator shall evaluate each of the subject causes for flooding at the selected Facility and determine which ones have

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realistic and important considerations for the purposes of this assessment. For those that are not of high importance, they should be dismissed qualitatively, with a brief summary of the basis for dismissal. The remaining evaluated worst case flooding scenarios should then be described and further discussed in the flooding analysis.

Site Type – The evaluation should identify the type of the Facility being analyzed, i.e., a “Greenfield,” “Brownfield,” or “an existing nuclear power plant site”. The evaluation should identify the unique applicability of site type-related differences, if any, for the treatment of this issue. In addition, the evaluation should take into consideration existing data and analyses that might be available, for example, in the case of an existing nuclear site or, perhaps, a “Brownfield site.” In these cases the additional flooding analysis may not be needed and the overall confidence level in the analysis results may be very high compared to a “Greenfield site”, which may not have any pre-existing flooding analysis to review.

Evaluation criteria - The Facility should not be located in 100-year or 500-year flood zone. The FEMA Flood Hazard Maps may be used to determine whether the Facility is in a FEMA flood zone.

A flooding analysis should be performed to estimate the preliminary PMF water surface elevation along with an appropriate safety factor.

The Facility should be classified as “Acceptable Site” if the analysis indicates that the Facility is a “Dry Site,” i.e., the flood level elevation does not reach the ground level elevation in the area where the plant is likely to be located (e.g., is at least 5-10 ft below the Facility grade elevation).

The Facility should be classified as “Challenged Site Requiring Further Evaluation” if the flooding level elevation is at or slightly below ground level elevation in the area where the Facility is likely to be located (e.g., is 0-5 ft below the Facility grade elevation).

The Facility should be classified as “Site Not Suitable” if the flood level elevation is expected to be above the Facility ground surface elevation, and mitigation measures are deemed impractical.

RG 1.102 describes acceptable flood protection measures. It should be used in conjunction with the following guidance to determine final site acceptability.

Flooding analysis

A preliminary PMF estimate at the Facility may be quickly estimated using Regulatory Guide 1.59 (RG 1.59). RG 1.59 describes methods for estimating the PMF for plants located on streams, along lakeshores, coastlines, and estuaries. Although the methods contained in RG 1.59 are based on superseded

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materials, the simplified alternative method using isoline maps requires only the drainage area as input and may be used as a basis for a preliminary PMF estimate. The drainage area may be estimated using United States Geological Services (USGS) stream gauge information, quadrangle topographic maps, or other topographic sources. A cross section at or near the Facility may be estimated using USGS quadrangles. The estimated PMF may then be translated to a water surface elevation using models such as FlowMaster, HEC-RAS, hand calculations, etc.

RG 1.59 states that “Analyses of only the most severe flood conditions may not indicate potential threats to safety related structures; however a combination of less and most severe flood conditions pose threat to safety related structures.” Therefore, a reasonable combination of less-severe flood conditions should also be considered, to include dam failure permutations and coincident wind wave activity as appropriate. Because RG 1.59 is based on previous probable maximum precipitation (PMP) information prior to most or all of the Hydrometeorological Reports (HMRs) currently in use, it would be prudent to use an increased safety factor when estimating the PMF from the RG 1.59 isoline maps. It is recommended to increase the preliminary PMF result by 25-50 percent for allowance of this safety factor. It is recommended to use a higher safety factor for Greenfield Sites (i.e. 50 percent) compared to existing nuclear power plants (i.e. 25 percent). The safety factor accounts for unknowns such as antecedent conditions, nonlinear basin response, current HMRs, more detailed hydraulic modeling, dam failures, wind wave, etc. that may not have been incorporated in the RG 1.59 preliminary PMF estimate.

Generally the PMF provides the design basis flood for the Facilities along rivers and streams. For sites along lakes or seashores, the design basis flood may be produced by the most severe combination of hydrometeorological parameters, such as PMP, probable maximum seiche or probable maximum hurricane. In the case of sites located on estuaries the probable maximum river flood, probable maximum surge or probable maximum seiche or a reasonable combination may produce the design basis flood.

For the Facilities along or near open coastal areas of the Gulf of Mexico and the Atlantic Coast, RG 1.59 may be used to estimate the probable maximum surge based on the probable maximum hurricane. The probable maximum surge data along the Atlantic coast and the Gulf of Mexico are shown in tables and figures in RG 1.59, Appendix C. RG 1.59 suggests interpolating between these values depending upon the location of the Facility. As stated earlier, the methods contained in RG 1.59 are based on superseded materials; it is recommended to increase the

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estimated surge result by 25 percent for allowance of safety factor to account for coincident wind wave activity and superseded data.

For the Facilities along the Pacific coast, ANSI/ANS-2.8-1992 points out tsunamis may generate higher floods. The historical tsunami data may be referenced along with the PMF to determine the water surface elevation at the Facility along the Pacific coast. Although ANSI/ANS-2.8-1992 has been withdrawn, as of August 2009 a replacement standard has not been issued by the American Nuclear Society. The NRC NUREG-0800, March 2007 includes ANSI/ANS-2.8-1992 as a historical technical reference. The historical tsunami may not result in the probable maximum tsunami as described in Regulatory Guide 1.206. Therefore, it is recommended to increase the historical tsunami elevation by at least 25 percent to allow a safety factor for probable maximum tsunami.

Risk - The discussion of each risk factor should include the relevance of the Facility to the level of risk. Some typical risk factors for flooding include, but are not limited to, the following:

- Proximity and size of upstream and downstream reservoirs
- Site Topography
- Seismic activity levels at the Facility
- Probability of severe weather (e.g., tornadoes, hurricanes, etc.)

Additionally, if the Facility safety related structures are at or below the design basis flood elevation, the Facility may be elevated by fill. However, if the fill required to prevent the Facility from flooding is significant, its effect on other aspects of the plant such as ecological, groundwater etc. should be taken into consideration.

Risk Mitigation – If the Facility is considered as “Challenged Site Requiring Further Evaluation” the flood protection measures as suggested in RG 1.02 may be considered. Also the Facility may be elevated enough to be considered as “Acceptable Site”. Risk can also be mitigated by proper data collection such as topographic information etc.

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REFERENCES:

1. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.102, Revision 1, "Flood Protection for Nuclear Power Plants", September 1976.
2. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants", June 2007.
3. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.59, Revision 2, "Design Basis Floods for Nuclear Power Plants", August 1977.
4. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.7, Revision 2, "General Site Suitability Criteria for Nuclear Power Plants," April 1998.
5. U. S. Nuclear Regulatory Commission, NUREG-0800, "Standard Review Plan," May 2007.
6. ANSI/ANS-2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites," July 28, 1992.

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HEALTH AND SAFETY CHARACTERISTICS TEMPLATES

NEARBY HAZARDOUS ACTIVITIES/FACILITIES THAT COULD AFFECT PLANT SAFETY

Nearby Hazardous Activities

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SITE CHARACTERISTIC: HEALTH AND SAFETY / Nearby Hazardous Activities

DESCRIPTION: The identification of nearby hazardous activities located in association with potential candidate sites may include the analysis of a number of factors, including transportation facilities and routes such as airports, airways, roadways, railways, pipelines, and navigable water bodies. Hazardous activities could also be associated with nearby industrial facilities and military complexes. In addition, the presence of on-site storage facilities would be subject to identification and analysis as potentially hazardous to plant operations.

IMPORTANCE: Federal regulations including 10 CFR 100.20(b) requires that “the nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, military and chemical facilities must be evaluated to establish site parameters for use in determining whether a plant design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low.” 10 CFR 100.21(b)(e) further states that upon evaluation and the subsequent establishment of site parameters, the applicant would demonstrate 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 identified parameters are factors applied to the analysis undertaken for SRP 2.2.3 to determine potential accidents regarded as design-basis events. The details of activities associated with nearby transportation routes, military and industrial facilities would also be used in analysis for SRP 6.4 in establishing the parameters for control room habitability following the accidental release of toxic gases or vapors.

RISK: The NRC Staff will review the nature and extent of activities involving potentially hazardous materials or activities that are conducted at nearby industrial, military, and transportation facilities, etc., to identify any such activities that have the potential for adversely affecting plant safety-related structures. According to SRP 2.2.1-2.2.2, collection and analysis of data pertaining to the identified parameters supports the determination of whether design-basis events could have “potential consequences sufficiently serious to affect the safety of the plant to the extent that 10 CFR Part 100 guidelines could be exceeded.” The inability to demonstrate sufficient design contingencies or provide assurance that the plant has adequate protection and can operate with an acceptable degree of safety in the event of an offsite accident involving hazardous materials, could result in the rejection of the application and/or the candidate site.

- EVALUATION:**
- Acceptable Site**
 - Challenged Site Requiring Further Evaluation**
 - Site Not Suitable**

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DISCUSSION:

The identification of potential hazards within 5 and 10 miles (8 and 16 km) of a candidate site, including the nature and extent of activities associated with transportation routing, industrial, and military facilities, is necessary in establishing the degree of risk these parameters could potentially pose to the safety of a proposed facility. Once nearby potential hazards are identified, these become the basis for evaluating the risk potential, as described in NRC Regulatory Guide 4.7, Rev 2. Ultimately, the hazards analysis presented in various candidate site application documents are also dependent on knowledge of design characteristics unique to the type of plant technology designated for use at the site and the incorporation of appropriate engineering safeguards designed to withstand potential accidents.

Site Type - The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield”, or “existing nuclear power plant” site. If a candidate site is considered a “Brownfield” site and has experienced previous industrial use, or the site is associated with an existing nuclear power plant, data and previous analysis may be available to help identify nearby potential hazards. But, because hazards analysis is unique to each site, and somewhat dependent on the type of facility technology being utilized, an in-depth analysis would still be necessary to adequately identify the risks posed by hazards in the area. The same strategy would be necessary in hazards analysis associated with a “Greenfield” site.

Evaluation criteria - The site should be classified as “Acceptable Site” when no hazardous sites are identified within 10 miles (16 km) of the proposed plant site.

The site should be classified as “Challenged Site Requiring Further Evaluation” when hazardous sites and activities are identified within 10 miles (16 km) of the proposed plant site.

A Site Not Suitable evaluation cannot occur at this level of evaluation. All identified nearby hazardous activities will require additional evaluation per SRP guidance. If the probability and accident analyses exceed the defined thresholds, mitigation may be possible.

Data Collection - For each of the analysis parameters, evaluation criteria for identifying nearby sites with potential hazards are based on the Safety Analysis Standard Review Plan (NUREG-0800) and the detail of information gathered should include:

- Data that adequately describes the locations and distances from the candidate plant to nearby industrial, military, and transportation facilities, and
- Descriptions of the nature and extent of activities conducted at the candidate site and in its vicinity, including

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the products and materials likely to be processed, stored, used, or transported, are adequate to permit identification of the possible hazards, and

- o Sufficient statistical data with respect to hazardous materials are provided to establish a basis for evaluating the potential hazards to the candidate plant.

Establishing the location of nearby hazards is based on identification of the presence of industrial, military, and transportation facilities and routes within 5 miles (8 km), and according to RG 4.7, 10 miles (16 km) for major airports and airways. Facilities and activities located at a distance greater than 5 miles (8 km) should be evaluated if they have the potential of affecting plant safety-related features. Along with verifying distance, and the nature and extent of activities, details should include verification of potentially hazardous materials used, stored, or transported, and determination of the quantity and frequency of shipment. Bulk storage on the plant site of potentially hazardous materials should also be taken into consideration. To the extent that definitive information is available, potential hazardous activities that may be located within 5 and/or 10 miles (8 and/or 16 km) of the proposed plant during its operational life should also be considered.

Risk - According to RG 4.7, the acceptability of a site based on nearby potential hazards would depend on establishing the following:

- o an accident at a nearby industrial, military, or transportation facility would not result in radiological consequences that exceed the dose specified in 10 CFR 10.34, or
- o the accident poses no undue risk because it is sufficiently unlikely to occur (less than about 10^{-7} per year), or
- o the nuclear power station can be designed so its safety will not be affected by the accident.

According to NUREG-0800, the risk analysis from nearby hazards is discussed in various SRP sections including 2.2.3, 3.5.1.5, and 3.5.1.6, with analysis parameters specific to those sections. The outcome is also discussed in a variety of potential applicant documents including a construction permit, operating license, design certification, early site permit, and/or combined license. Review procedures associated with these particular documents is specific to various sections of 10 CFR Part 52.

Risk Mitigation - If a nearby hazardous activity was identified, more detailed analysis would be required that include probability and accident analyses. Also, further investigation would be

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necessary if this analysis of nearby hazards exceeds the evaluation criteria for risk analysis described in SRP Sections 2.2.3, 3.5.1.5, and 3.5.1.6.

If the probability of the identified activity or accident proved to be above the thresholds listed within the SRP, mitigation may be necessary and expensive (e.g., move site or control room location, engineering safeguards). Also, if a site with potentially hazardous materials was missed in the original evaluation or insufficient data was collected, additional research would be required detailing the data and subsequent risk analysis would take place. This could include revision of plant design safety features, research, and/or revised calculations.

REFERENCES:

1. 10 CFR 100.20(b), "Factors to be considered when evaluating sites"
2. 10 CFR 100.21(b)(e), "Non-seismic siting criteria"
3. 10 CFR 52, (various sections), "Licenses, Certifications, and Approvals for Nuclear Power Plants"
4. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," April 1998
5. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.2.1-2.2.2, "Identification of Potential Hazards in Site Vicinity"
6. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.2.3, "Evaluation of Potential Accidents"
7. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 6.4, "Control Room Habitability System"

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HEALTH AND SAFETY CHARACTERISTICS TEMPLATES

Extreme Weather Conditions

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SITE CHARACTERISTIC: HEALTH AND SAFETY / Extreme Weather Conditions

DESCRIPTION: Meteorological data must be of high quality and representative of the proposed site. The potential for limiting conditions from extreme weather at a candidate site may involve numerous factors, including local probable maximum precipitation, maximum probable wind speed and severe wind events, hurricanes, tornadoes and waterspouts, thunderstorms, lightning and hail, freezing rain and ice storms, dust storms, 100 year return snowpack, weight of the 48-hour probable maximum winter precipitation, maximum dry bulb temperature and ambient temperature, or any of various combinations of these events, such that design or safety parameters would be exceeded. 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 also be considered in evaluating the suitability of potential sites.

IMPORTANCE: 10 CFR 100.21(d) requires physical characteristics of the site, including meteorology, to be evaluated and site parameters established such that potential threats from such physical characteristics will pose no undue risk to the type of facility proposed.

NUREG-0800 Section 2.3.1 and 2.3.2 provides guidance for acceptance criteria of the meteorological parameters from the requirements of 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," as it relates to consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

Data summaries from National Weather Service (NWS) stations or other installations in the nearby area (50 miles (80 km) radius) should be presented as specified in Regulatory Guide (RG) 1.70 Section 2.3.2 and RG 1.206 Section 2.3.2.1. When offsite data are used, a determination is made of how well the data represent site conditions and whether more representative data are available. Onsite data systems, following Reg. Guide 1.23, could be installed if conditions prevent use of offsite data sources but would require at least one year but preferably two or more years of collection time. After the siting phase, onsite data should be collected and used.

RISK: To ensure that the evaluation of the listed extreme weather parameters is sufficient for a successful NRC review of an applicant document, high quality meteorological data and representativeness are required. The lack of quality data poses

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the greatest risk in siting a new nuclear plant. Calculated values based on historical data from offsite sources is the highest “at risk” activity since all design and decisions proceed assuming that the information used was correct. If it is determined that the offsite data was not representative of the proposed site, several years of work and the capital investment could be lost. An onsite meteorological system installed after the decision to use the proposed site could show the offsite data is not representative and that would cause extensive rework or worse.

The study of tornadoes and other high wind meteorological conditions is based mainly on research and studies dealing with tornadoes and their characteristics. The ability to classify the tornadoes that have been experienced in the area of the proposed site is the limiting factor to developing this parameter accurately. This parameter is of low risk as the value can be derived from extensive research. Also, more data is becoming available all the time and more models have been developed.

Research into hurricanes/tropical storms and the potential for snow loading is location based. An accurate historical picture of the frequency of occurrence should be considered for each site individually.

The other described extreme weather parameters, including hail, lightning, high wind events, etc. are taken into consideration with more severe meteorological events and safety features are typically engineered into the plant design.

EVALUATION:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION:

The most important data in the analysis of the outlined extreme weather parameters is the hourly historical averages for meteorological parameters such as wind speed, wind direction, ambient temperatures and wet bulb temperatures, delta temperatures, sigma theta, relative humidity, and precipitation. These averages are the source data of much of the analysis that determines bounding conditions, cooling system performance, reactor performance, and other design characteristics of the facility.

Data on hurricanes, tornadoes, thunderstorms, etc., need to be from reliable sources and from quality research and studies. This data is analyzed and used as the design basis for structures, systems, and components (SSCs), and important in the safe design and siting of a candidate plant.

Tornadoes - Due to the violent nature of tornadoes, these severe storms are of particular concern in siting a nuclear plant. The

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historical account of the occurrence of tornadoes in a particular area is important but is only part of the evaluation of tornadoes. Much of the data from tornadoes comes from visual observation, theoretical calculations, and physical examination of the effects of the tornado on the environment. Research and classification of tornadoes is an ongoing project and care is needed in determining the parameters required. Data is compared to plant design parameters used in establishing pressure and tornado missile loadings. Since very few individual tornadoes are monitored directly, most data is derived from the ongoing research and the representativeness of the data to the site location.

Hurricanes and Tropical Storms – Determined by the historical number of events and the classification of those events. Hurricanes are measured in Categories 1 through 5 based on storm wind speed. Hurricane damage depends on proximity to the landfall area, the speed of the storm moving inland, the straight line winds, and the amount of rainfall and the size and number of thunderstorms and tornadoes produced along with the tropical storm.

Site type - If the proposed site is an existing nuclear facility then the likelihood that the meteorological data will be sufficient is greatly enhanced since the meteorological data has already been determined. Operating nuclear plants may not have relative humidity or wet bulb temperature data which would have to be obtained from an offsite source if needed to design a new facility.

If the proposed site is a “Greenfield” site it is important that the historical source data will be representative. If the proposed site is a “Brownfield” site it is important that the historical source data will be representative and that no interference exists from the industrial facilities found on the “Brownfield” site.

Evaluation Criteria - An Acceptable Site occurs when no unacceptable extreme weather parameters are identified in association with the potential candidate site and representative historical meteorological data is available for those parameters needed to determine bounding limits and design acceptability.

A Challenged Site (Requiring Further Evaluation) occurs when unusual extreme weather parameters have been identified and further evaluation is necessary and the available historical data is questionable or missing important parameters.

A Site Not Suitable evaluation cannot occur at this level of evaluation. All identified extreme weather parameters will require additional analysis based on SRP guidance. If the probability and accident analyses exceed the defined thresholds, mitigation may be required.

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Extreme weather data and representativeness - Data summaries from NWS stations or other installations in the nearby area (50 miles (80 km) radius) should be presented as specified in Regulatory Guide (RG) 1.70 Section 2.3.2 and RG 1.206 Section 2.3.2.1. When offsite data are used, a determination is made of how well the data represent site conditions and whether more representative data are available. Representativeness is based on distance from the site, topography, elevation, mountains and valleys, land use, nearby bodies of water or ocean coastlines, and data collection procedures. If the data being used is not representative of the site then the data evaluations may be invalid. Both RG 1.70 and RG 1.206 stress the necessity that the meteorological data submitted in application documents should be fully documented and substantiated as to the validity of its representation of conditions at and near the site. The absence of quality data that is representative of the site may lead to elimination of the site from consideration.

10 CFR 100.21(d) requires physical characteristics of the site, including meteorology, to be evaluated and site parameters established such that potential threats from such physical characteristics will pose no undue risk to the type of facility proposed.

Tornado and hurricane/tropical storm data - SRP 2.3.1- 2.3.2 refer to the meteorological conditions that should be considered in the development of plant design and safety related features. Tornado parameters include maximum wind speed, translational speed, rotational speed, and maximum pressure differential with the associated time interval, to be used in establishing pressure and tornado missile loadings on SSCs important to safety. RG 1.26 states that determination of design-basis events internal and external of the nuclear plant, including tornadoes, are defined as those accidents that have a probability of occurrence on the order of magnitude of 10^{-7} per year or greater and potential consequences serious enough to affect the safety of the plant to the extent that the guidelines in 10 CFR Part 100 could be exceeded. According to RG 1.76, nuclear power plants must be designed so that they remain in a safe condition under severe meteorological events, including those that could result in the most severe tornado that could reasonably be predicted to occur at the site.

RG 1.76 states that tornado wind speeds may not bound hurricane wind speeds for certain portions of the Atlantic and Gulf coasts. The NRC would address these extreme conditions on a case-by-case basis.

Risk – The highest risk from meteorological data supporting the proposed site selection comes from the representativeness of the

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available data. If the data is determined to be; unavailable, not for a long enough timeframe, not representative of the proposed site, or later determined to be unusable after onsite data is collected, then the entire project may be in jeopardy.

Beyond representativeness of the data, tornado information is of lower risk since most designs will have no problem meeting bounding parameters.

Risk Mitigation – Risk can be mitigated by careful selection of source data. NWS, NOAA, and military sources of data are usually collected from the correct sensors and reported in the necessary formats. A thorough evaluation of representativeness must be performed. The evaluation must use factors such as topography, elevation, land use, water-bodies, etc. Finding quality data is the best method of mitigating risk. If a problem is found with plant design based on extreme weather analysis, revisions to SSCs would be required to support the project.

REFERENCES:

1. 10 CFR 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena"
2. 10 CFR Part 100, "Reactor Site Criteria"
3. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.3.1, "Regional Climatology"
4. U. S. Nuclear Regulatory Commission, NUREG-0800, SFP 2.3.2, "Local Meteorology"
5. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.23, "Onsite Meteorological Programs"
6. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants"
7. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.76, Rev. 1, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants"
8. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)"

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HEALTH AND SAFETY CHARACTERISTICS TEMPLATES

RADIOLOGICAL CONSIDERATIONS

Atmospheric Dispersion – Accident Conditions

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SITE CHARACTERISTIC: **HEALTH AND SAFETY / RADIOLOGICAL CONSIDERATIONS /
Atmospheric Dispersion – Accident Conditions**

DESCRIPTION: The objective of this criterion is to evaluate the suitability of the candidate sites with respect to short-term atmospheric dispersion characteristics, as a measure of the relative level of concentrations that could occur during accident conditions at the sites.

Because only short term exposures are of concern during accidents, worst-case (e.g., 5 percentile) short-term atmospheric dispersion (χ/Q) estimates are of concern for this siting criterion.

The efficiency of atmospheric diffusion is primarily dependent on wind speed, wind direction, and the change in air temperature with height which affects atmospheric stability. These factors are used to calculate the short term atmospheric dispersion.

The best way to calculate atmospheric dispersion (χ/Q) is using at least one year of on-site meteorological data; however, this data may not be available for all candidate sites. Data for the development of representative accident χ/Q values for regions of interest and candidate areas are generally available from National Oceanic and Atmospheric Administration (NOAA), states, universities, or private sources (e.g., meteorological observations acquired for power generation or industrial facilities, and private airfields). Because exclusionary criteria are provided for two distances and five accident averaging periods, the expected χ/Q values can only be determined from hourly meteorological observations. In the absence of hourly observations, joint frequency distributions (JFD) of wind speed and directions by stability class, if available, can be used to develop surrogate χ/Q values for use in identifying exclusionary and avoidance areas and evaluating site suitability. Should atmospheric dispersion become a sensitive criterion for site selection, site-specific meteorological data should be obtained to calculate an atmospheric dispersion function (χ/Q) for more accurate site comparison.

IMPORTANCE: The atmospheric dispersion values for the site are important because they are used to demonstrate that the post-accident doses at the EAB and LPZ meet the site criteria given in 10 CFR Part 100, "Reactor Site Criteria". § 100.21(c) gives the overall requirements relative to accident dose consequences as follows:

c) Site atmospheric dispersion characteristics must be evaluated and dispersion parameters established such that:

- (1) Radiological effluent release limits associated with normal operation from the type of facility proposed to be located at the site can be met for any individual located offsite; and

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(2) Radiological dose consequences of postulated accidents shall meet the criteria set forth in § 50.34(a)(1) of this chapter for the type of facility proposed to be located at the site;

The specific requirements relative to the EAB and LPZ are given in § 50.34(a)(1)(ii)(D) as follows:

(1) An individual located at any point on the boundary of the exclusion area for any 2 hour period following the onset of the postulated fission product release, would not receive a radiation dose in excess of 25 rem total effective dose equivalent (TEDE).

(2) An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a radiation dose in excess of 25 rem total effective dose equivalent (TEDE);

RISK:

The NRC Staff will review the site specific atmospheric dispersion values for the EAB and LPZ to confirm site suitability. If there is little margin between the site specific accident doses and the 10 CFR 100 regulatory dose limits, any significant change in the χ/Q values may result in the site being classified as unacceptable. This situation could be remedied by increasing the EAB or reducing the post-accident radionuclide releases. This approach agrees with § 100.10(d) which states “Where unfavorable physical characteristics of the site exist, the proposed site may nevertheless be found to be acceptable if the design of the facility includes appropriate and adequate compensating engineering safeguards.”

EVALUATION:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION:

Estimates of short-term χ/Q s corresponding to the PPE values would be developed for each of the candidate sites. In addition to the analysis discussed above, this evaluation should also take into account site-specific characteristics (e.g., topography and coastal effects) that could affect dispersion of accidental releases. In the absence of on-site meteorological data, professional judgment will be required to adopt regional data to account for these local effects.

Site Type - The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield” or existing nuclear power plant site. The evaluation should identify the unique applicability of site type-related differences, if any, for the treatment of this issue. In addition, the evaluation should take into consideration existing data and analyses that might be available, for example, in the case of an existing nuclear site or, perhaps, a

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“Brownfield site.” In these cases the additional site-specific atmospheric dispersion analysis may not be needed and the overall confidence level in the analysis results may be very high compared to a “Greenfield” site.

Evaluation Criteria – A site would be classified as an Acceptable Site if the EAB doses for the proposed technology meet the limits of § 50.34(a)(1). A site would be classified as a Challenged Site Requiring Further Evaluation if the EAB doses do not meet the limits of § 50.34(a)(1) but could if design changes were implemented to limit accident radionuclide releases.

A site whose estimated dispersion characteristics do not satisfy the PPEs and increasing the exclusion area boundary or reducing the post-accident radionuclide releases is not possible would be classified as Site Not Suitable and eliminated from further consideration.

Atmospheric Dispersion Evaluation

The assessment of atmospheric dispersion is required by 10 CFR Part 100, “Reactor Site Criteria” and 10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants”.

Standard Review Plan (NUREG-0800) provides insight as to areas of review by the NRC Staff and should be consulted, as appropriate, to ensure that the evaluation is sufficiently comprehensive.

Site suitability can be judged by comparison of the site-specific atmospheric dispersion values with the specific values associated with a particular technology.

Atmospheric Dispersion (Chi/Q) - Accident		
Location	Time	Composite EPRI ALWR Value
EAB	0-2 hr	1.0E-3 sec/m ³
LPZ	0-8 hr	1.35E-4 sec/ m ³
	8-24 hr	1.00E-4 sec/ m ³
	1-4 day	5.4E-5 sec/ m ³
	4-30 day	2.2E-5 sec/ m ³

The EPRI Chi/Q values above are based on the typical radial distance to the EAB boundary of 0.5 miles (800 m), and a distance to the LPZ boundary established at a 2-mile (3.2 km) radius, from the reactor plant location. For a reactor technology with lower licensed thermal power, these distances may be reduced (e.g.,

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the NGNP project goal for the EAB boundary is 0.25 miles (400 m); therefore, the values given in the table above could not be used without modification for the change in distances.

The calculation of atmospheric dispersion factors can be performed by using the PAVAN computer program, which is also used by the U.S. Nuclear Regulatory Commission for this type of evaluation. The computer program, PAVAN, implements the guidance provided in Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants".

The atmospheric dispersion evaluation should be based on the guidance provided in Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants". In accordance with SRP 2.3.4, two probabilistic approaches as described in Regulatory Guide 1.145 are applied for evaluating atmospheric dispersion characteristics and the more conservative approach is used.

- A) A direction-dependent probabilistic approach which uses the highest χ/Q value which is exceeded 0.5% of the time in each of 16 compass directions from the plant.
- B) A direction-independent probabilistic approach which uses the χ/Q value which is exceeded 5% of the time independent of direction. χ/Q values should be determined for the exclusion area boundary (EAB) and the low population zone (LPZ) distances assumed for the site.

Risk - The atmospheric dispersion analysis (and completed Evaluation Template) should clearly articulate the risk factors associated with the analysis or assumptions. The discussion of each risk factor should include the relevance of the site type to the level of risk. Some typical risk factors for atmospheric dispersion include the following:

- Proximity of meteorological data source to the site
- Quality of meteorological data
- Length of data record available
- Applicability of meteorological data to the site (considering terrain, distance to site, distance from land features which may influence measurements, elevation, distance from nearby structures)
- Topography of the site and of the area surrounding the data source.

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Sites with poor meteorological conditions will result in higher atmospheric dispersion values which will, in turn, produce higher doses. To counteract this situation would require a larger EAB or compensatory design changes to reduce radionuclide releases. [Generally, the LPZ atmospheric dispersion values are acceptable for a 2 mile (3.2 km) radius LPZ.] If the atmospheric dispersion factors are determined using other than site data, an appropriate margin (suggest a factor of 50%) should be used to account for the possible increase in results due to later use of site data.

Risk Mitigation – The risk of a potential site being rejected can be minimized by selecting a technology that has low offsite doses due to minimizing post-accident radionuclide releases. The atmospheric dispersion factors given in the PPE are an indication of the magnitude of offsite doses. A technology with a higher EAB atmospheric dispersion value would be easier to site.

REFERENCES:

1. U. S. Nuclear Regulatory Commission, NUREG/CR-2858, PNL-4413, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations", November 1982.
2. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Revision 1, November 1982 (Revised February 1983 to correct page 1.145-7).
3. 10 CFR Part 100, "Reactor Site Criteria."
4. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."
5. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," Revision 2, April 1998.
6. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," June 2007.
7. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.3.4, "Short-Term Atmospheric Dispersion Estimates for Accident Releases."
8. EPRI, "Advanced Light Water Reactor Utility Requirements Document," Revision 8.

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HEALTH AND SAFETY CHARACTERISTICS TEMPLATES

Emergency Planning

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SITE CHARACTERISTIC: HEALTH AND SAFETY / Emergency Planning

DESCRIPTION: A potential emergency at a candidate site may involve the release of radioactive materials to the environment at levels that could affect the health and safety of the public living near the nuclear power plant site under consideration. Onsite and offsite emergency plans are required to assure that adequate protective measures can be taken to protect onsite workers and the public in the event of a radiological emergency. Federal oversight of emergency planning for licensed nuclear power plants is shared by the Nuclear Regulatory Commission (NRC) and the Federal Emergency Management Agency (FEMA) through a memorandum of understanding. However, with respect to issuing an ESP or COL, the final decision making authority on the adequacy of emergency planning and preparedness rests with the NRC.

IMPORTANCE: Determining the suitability of a site for constructing a new nuclear power plant should consider the emergency planning regulatory requirements promulgated by the NRC. These regulations are contained mainly in 10 CFR 50.47 and Appendix E to Part 50 for operating licenses (OL) and Early Site Permit (ESP) applications with a "full and integrated emergency plan," and combined licenses (COL), 10 CFR 52.17 for ESPs, and 10 CFR 52.79 for COLs.

OL and COL regulations require an analysis of the time required to evacuate and for taking other protective actions for various sectors and distances within the plume exposure pathway emergency planning zone (EPZ) for transient and permanent populations.

With regard to the ESP, 10 CFR 52.17(b) regulations specifically require that the site safety analysis report identify physical characteristics of the proposed site that could pose a significant impediment to the development of emergency plans.

In order for the NRC to issue a license to operate a commercial nuclear power plant, emergency plans must provide reasonable assurance that adequate protection can and will be taken in the event of a radiological emergency at the plant.

RISK: The NRC Staff will evaluate the onsite emergency plan and FEMA will take the lead in evaluating the offsite emergency plans. These emergency plans will be evaluated against the 16 emergency planning standards set forth in 10 CFR 50.47(b) and further described in 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" (NUREG-0654). These planning standards define the responsibilities of the licensee and the State and local organizations involved in emergency response.

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The NRC regulations do not specify a specific evacuation time that must be met for a candidate site to be deemed suitable for construction and operation of a nuclear power plant. However, the formal analysis of evacuation times can identify physical characteristics unique to the proposed site that could pose a significant impediment to the development of emergency plans. Such impediments must be identified and any mitigative strategies presented.

The inability to provide reasonable assurance that adequate protection can and will be taken in the event of a radiological emergency could result in the rejection of the site for the nuclear plant application.

EVALUATION:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION:

The overall objective of emergency planning is to ensure that the nuclear power plant operator is capable of implementing adequate measures to protect worker and public health and safety in the event of a radiological emergency. As a condition of their license, operators of nuclear power plants must develop and maintain emergency plans that meet comprehensive NRC emergency planning requirements. Increased confidence in public protection is obtained through the combined inspection of the requirements of emergency preparedness and the evaluation of their implementation.

The evaluation of site suitability with respect to emergency planning considers three major areas: risks or challenges to meeting regulatory requirements and related guidance; presence of significant impediments to development of emergency plans; and overall public acceptance of building a nuclear plant at the proposed site.

Emergency planning regulations and guidance focus on 16 planning standards. Each of these planning standards must be met in order for NRC to find reasonable assurance that adequate protection can and will be taken in the event of a radiological emergency. The Evaluator should consider any barriers to addressing these planning standards in the ESP or COL application. Four "Risk Significant Planning Standards" must be achievable for the site to be considered as suitable: timely and accurate classification of events; timely and accurate notification of offsite governmental authorities; timely and accurate development of public protective action recommendations for offsite authorities; and assessment of offsite consequences. Three of these planning standards are mainly applicant or technology influenced and would not be expected to impact the suitability

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evaluation. However, the fourth planning standard, dealing with notification of offsite governmental authorities can be directly impacted by these entities support (or lack thereof) of operating a nuclear plant at the site under consideration.

Physical characteristics unique to the proposed site could pose a significant impediment to the development of emergency plans. The evaluator is expected to identify possible impediments to onsite and public evacuation at the selected site and determine which ones, if any, have realistic and important considerations for the purposes of this Evaluation. For those that are not of high importance, they should be dismissed qualitatively, with a brief summary of the basis for dismissal. The remaining concerns should then be discussed in the emergency planning analysis.

Public confidence in nuclear plant operation and safety frequently surfaces in expressed concern with emergency planning; particularly public evacuation. The evaluator will need to gauge the overall public acceptance of a proposed nuclear plant, including evaluation of the existing State and local emergency management infrastructure.

Site Type - The evaluation should identify the type of site, i.e., a “Greenfield”, “Brownfield” or existing nuclear power plant site, as well as the location of the site being evaluated. The evaluation should consider the applicant’s prior nuclear experience and the maturity of emergency plans based on the site type. In particular, the evaluation should consider existing site emergency plans if the site being evaluated has an existing nuclear power plant. Existing emergency planning can be directly applied to licensing of a new nuclear plant. Onsite emergency response organizations would need to be expanded to accommodate a new unit, but the offsite (State and local) emergency response is largely unaffected by any additional units at an existing site. Emergency planning will still require a significant effort to support the license application requirements and the risks discussed below should be considered and addressed accordingly.

Existing knowledge of any impediments to relocating the public and methods to facilitate movement and optimize evacuation times can be directly applied to the licensing of a new nuclear plant. Detailed evacuation time studies are not warranted for a site suitability evaluation, but proximity and size of population centers and sophistication of the roadway network can be qualitatively evaluated.

For Greenfield sites, the evaluation should consider whether existing nuclear power plants are located in the same State or local area as the site being evaluated. Offsite relationships are well-established if the site being evaluated is located in a State or area with an existing nuclear power plant. Additionally, prior NRC

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and FEMA acceptance of existing state and local emergency plans provide reasonable stability in the planning effort required for a new license application. In general, selecting a site in a State with an existing radiological emergency planning program presents less risk and cost to develop a successful radiological emergency preparedness and response program than for a Greenfield site located in a State without an existing nuclear plant radiological emergency plan.

Evaluation Criteria – The site should be classified as an Acceptable Site if no barriers to meeting each of the 16 regulatory planning standards have been identified; no significant impediments to development of emergency plans have been identified; or public opinion is definitively in favor of new nuclear plant construction.

The site should be classified as a Challenged Site Requiring Further Evaluation if one or more planning standards (other than the four “Risk Significant Planning Standards”) cannot be met; impediments to emergency plan development are identified, but can be mitigated; or public support is not definitive, but political support is strong.

The site should be classified as a Site Not Suitable if any “Risk Significant Planning Standard” cannot be achieved; impediments to emergency plan development cannot be mitigated or represent significant cost to mitigate; active public and political opposition.

Emergency Planning Analysis

The regulations contained in 10 CFR 50.47 and Appendix E to Part 50 related to OL and COL, 10 CFR 52.17 for ESP, and 10 CFR 52.79 for COL applications should be considered in determining the feasibility of constructing a new nuclear power plant. Regulatory Guide 1.101, Rev. 5 states that the criteria and recommendations in NUREG-0654 are considered by the NRC staff to be acceptable methods for complying with the standards in 10 CFR 50.47.

Regulatory Guide 1.206, “Combined License Applications for Nuclear Power Plants” (RG 1.206) provides guidance to applicants for a COL and the information presented is reflected in NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants” (NUREG-0800). NUREG-0800 provides insight as to areas of review by the NRC Staff. Both documents should be consulted, as appropriate, to ensure that the evaluation is sufficiently comprehensive. It is anticipated that the emergency planning requirements for an NGNP reactor technology may be different than for large light water reactors (e.g. planning zone distances); the evaluator

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should verify the status of these requirements for a non-light water reactor during the evaluation.

Section IV of Appendix E to 10 CFR Part 50, through 10 CFR 52.79(a)21 and 10 CFR 50.34, require that an application for an OL or a COL, provide an analysis of the time required to evacuate various sectors and distances within the plume exposure pathway EPZ. Appendix 4 of NUREG-0654 provides guidance on preparing evacuation time estimates. For an ESP application, 10 CFR 52.17(b)1 requires that applicants identify physical characteristics unique to the proposed site that could pose a significant impediment to the development of emergency plans. Supplement 2 to NUREG-0654 contains additional guidance for ESP applicants for determining significant impediments to the evacuation or taking of other protective actions as well as determining if physical impediments pose an impediment to the development of emergency plans.

NUREG-6863, “Development of Evacuation Time Estimate Studies for Nuclear Power Plants” provides additional information on ETEs.

As stated in Supplement 2 to NUREG-0654, the NRC regulations do not specify a minimum required evacuation time.

If this evaluation identifies any potential impediments to evacuation, the significance of the impediments and the estimated difficulty in overcoming the identified impediments should be evaluated to determine the final site acceptability.

The evaluator is expected to evaluate each of the pertinent regulatory requirements for content of the required emergency plans. These regulatory requirements are delineated in the “Addendum to the Emergency Planning Feasibility Evaluation Template”, included as Appendix D to this procedure.

Risk - The emergency planning analysis (and completed Site Suitability Evaluation Template) should clearly articulate the risk factors associated with the analysis or assumptions. The discussion of each risk factor should include the relevance of the site location to the level of risk. Some typical risk factors for emergency planning include, but are not limited to, the following:

- Regulatory Environment – Emergency planning requires coordination and cooperation from State and local agencies. Emergency planning for a new nuclear unit at an existing site presents the lowest level of risk to successfully licensing the new unit(s) than a Greenfield site. Two types of Greenfield sites must be considered: Greenfield sites in states with existing radiological emergency preparedness (REP) programs; and Greenfield sites in states without REP programs. For Greenfield sites in states with existing

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REP programs, the risk exists at the local level where little or no radiological emergency preparedness experience may reside. Political considerations may drive the level of cooperation that can be expected from State or local emergency management officials. Greenfield sites with no state REP experience would present the highest risk. In an area or State without existing nuclear power plants, there may be reluctance to provide information regarding existing emergency operations plans due to Homeland Security concerns. In all cases, early interaction with elected officials and State and local emergency management organizations is needed to establish working and cooperative relationships to more accurately assess risk. Although existing regulations allow remedies where state and local governments choose not to participate in planning responsibilities, cost and public relations will suffer and present a tremendous risk to successfully licensing the plant. A cooperative working relationship with State and local emergency management organizations is essential to successfully develop emergency plans required to license a commercial nuclear power plant. If the nuclear plant is to be co-located on a site with existing emergency planning procedures, the integration of nuclear emergency planning into the existing site emergency planning infrastructure should be evaluated.

- Guidance in Regulatory Guide 4.7 indicates that applicants must identify and consider site characteristics, such as egress limitations from the area surrounding the site that could pose a significant impediment to the development of emergency plans. Special population groups (e.g., those in hospitals, prison, or other facilities with special emergency situation needs) should also be taken into account. Sites with such emergency planning impediments, or with special population groups in the emergency planning zones, should be considered less suitable than sites that do not.

Characteristics to be considered in this evaluation include, but are not limited to, the following:

- Traffic Capacity
- Number of egress alternatives
- Roadway network type
- Population density within the EPZ
- Number of traffic control points
- Terrain characteristics unique to the proposed site

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- Public Involvement – Two aspects of public involvement should be considered: acceptance of a nuclear power plant by the public; and interaction with elected officials and offsite emergency management agencies. As appropriate, any feedback from early interaction between applicant senior management and elected officials will be helpful in determining public acceptance. The evaluator should not initiate such discussions directly with elected officials unless directed by applicant management. The evaluator should determine if any outreach programs to the community have been initiated or are planned. The evaluator should have discussions with state and local emergency management organizations to determine the level of preparedness in relation to the emergency planning requirements supporting nuclear plant licensing.

Ultimately, the willingness for state and local emergency management agencies, local fire/rescue services, and state and local law enforcement agencies to participate in emergency planning is essential to licensing a new nuclear plant. Early involvement of elected officials and emergency management organizations is important to identifying any concerns with the construction of a new nuclear plant. Outreach programs can help mitigate the risk of a negative response from the stakeholders.

Risk Mitigation - Early interaction with elected officials and State and local emergency management organizations is needed to establish working and cooperative relationships to mitigate risk. Although existing regulations allow remedies where state and local governments choose not to participate in planning responsibilities, cost and public relations will suffer and present a tremendous risk to successfully licensing the plant. A cooperative working relationship with State and local emergency management organizations is essential to successfully develop emergency plans required to license a commercial nuclear power plant.

Early involvement of elected officials and emergency management organizations is important to identifying any concerns with the construction of a new nuclear plant. Outreach programs can help mitigate the risk of a negative response from the stakeholders.

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REFERENCES:

1. 10 CFR 50.47, "Emergency Plans"
2. 10 CFR 50, Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities"
3. 10 CFR 52.17(a), "Contents of Applications; Technical Information"
4. 10 CFR 52.79(a)(21), (22), "Contents of Applications; Technical Information in Final Safety Analysis Report"
5. U. S. Nuclear Regulatory Commission, 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"
6. U. S. Nuclear Regulatory Commission, NUREG-0654/FEMA-REP-1, Rev. 1, Supp. 2, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants: Criteria for Emergency Planning in an Early Site Permit Application"
7. U. S. Nuclear Regulatory Commission, NUREG-6863, "Development of Evacuation Time Estimate Studies for Nuclear Power Plants"
8. U. S. Nuclear Regulatory Commission, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants", SRP 13.3, "Emergency Planning"
9. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.101, Rev. 5, "Emergency Planning and Preparedness for Nuclear Power Reactors"
10. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants", C.I.13.3, "Emergency Planning"
11. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," April 1998

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HEALTH AND SAFETY CHARACTERISTICS TEMPLATES

POPULATION

Population Density

Population Centers

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SITE CHARACTERISTIC: HEALTH AND SAFETY / POPULATION / Population Density

DESCRIPTION: The potential for impacting the regional population can be demonstrated by determining the population density to the site. According to NUREG-0800, the NRC will review data about the population in the region, including transient population, based upon the latest decennial census. This issue is difficult to mitigate, and may cause complications for any site being licensed by the NRC. This template will focus on using the NRC's guidance to evaluate whether a site has population issues that will reduce the likelihood of producing a successful application.

IMPORTANCE: Part 100, "Reactor Site Criteria," of Title 10 of the Code of Federal Regulations states that the population density be taken into account in determining the acceptability of a site for a nuclear power reactor. RG 4.7 states that 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 (32 km) (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.

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.

RISK: The NRC staff will review the population density out to 20 miles (32 km) from the site. As stated in 10CFR100.21(h), if the density is more than 500 persons per square mile for the entire 20-mile (32-km) radius, at a time that is 5 years from the initial site approval, the NRC may want to look at alternate sites with a smaller population density. The application will be at risk but it does not necessarily mean the site will be rejected.

- EVALUATION:**
- Acceptable Site**
 - Challenged Site Requiring Further Evaluation**
 - Site Not Suitable**

DISCUSSION: The potential impacts to the population in the region must be reasonable and appropriate. Locating reactors away from densely populated areas 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. While population information is readily available

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from the U.S. Census, information regarding transient population and population projection is not consistently available. Data on transient population and population projection can often be obtained from state or county agencies, as well as local universities.

Site Type - The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield”, or “existing nuclear power plant” site. The evaluation should identify the unique applicability of site type-related differences, if any, for the treatment of this issue. In addition, the evaluation should take into consideration existing data and analyses that might be available, for example, in the case of an existing nuclear site or, perhaps, a “Brownfield site.” In these cases the population density analysis may have been previously completed and evaluated, whereas a population density analysis will not have been completed for a Greenfield site.

Evaluation Criteria - As defined in RG 4.7 the population density should be less than 500 people per square mile for every mile in a 20 mile (32 km) radius from reactor center.

An Acceptable Site meets this criterion by having a population density, including transient populations, below 500 people per square mile.

A Challenged Site (Requiring Further Evaluation) occurs if it either a.) does not meet this criteria, or b.) it is likely to exceed the threshold if transient population or projection information is included.

A Site Not Suitable evaluation cannot occur based on 10 CFR 100.21.

Population Density Analysis

The population density calculation can be approximated using LandView6 from the U.S. Census. The 2000 population in all the radii from 1 mile to 20 miles (1.6 km to 32 km) can be obtained from the program. The density value can be calculated using $(\text{Radius Population})/(\pi*r^2)$.

To incorporate population projections, state or county projection information can be used to derive growth ratios that are applied to the latest decennial census. These ratios are produced by dividing the projected population by the U.S. Census 2000 value for the county. The population density can be further refined by making county wide transient population ratios that can be also applied to the U.S. Census 2000 value for the county. These ratios can then be applied to the LandView6 radii data to produce refined population density estimates.

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Risk - The NRC staff will review the population density analysis to determine if the site meets the criteria. If there is evidence that the site does not meet the population density criteria, the NRC may want to investigate an alternate site. In this instance, a reasonable argument supporting the location must be produced to keep the site viable.

Risk Mitigation - Performing a full GIS based population calculation, with a transient population analysis, will develop clear and supported population expectations from the site. Another option is to produce an argument using the sites benefits such as safety, environmental benefits, economic considerations, seismic characteristics, rail or highway access, shorter transmission line requirements, and less environmental impacts on undeveloped areas, wetlands, or endangered species.

REFERENCES:

1. 10CFR100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance"
2. 10CFR100.21, "Non-Seismic Siting Criteria"
3. 10CFR100.3, "Definitions"
4. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)"
5. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," April 1998
6. U. S. Nuclear Regulatory Commission, NUREG-1555, SRP 2.1, "Station Location"
7. U. S. Nuclear Regulatory Commission, NUREG-1555, SRP 2.5.1, "Demography"
8. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.1.1, "Site Location and Description"
9. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.1.3, "Population Distribution"

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SITE CHARACTERISTIC: HEALTH AND SAFETY / POPULATION / Population Centers

DESCRIPTION: The potential for impacting the regional population can be demonstrated by determining the nearest population centers to the site. According to NUREG-0800, the NRC will review data about the population in the region, including transient population, based upon the latest decennial census. The NRC will review the nearest boundary of the closest population center containing 25,000 or more residents to determine if the boundary is at least one and one-third times the distance from the reactor to the outer boundary of the Low Population Zone. These issues are difficult to mitigate, and may cause complications for any site being licensed by the NRC. This template will focus on using the NRC's guidance to evaluate whether a site has population issues that will reduce the likelihood of producing a successful application.

IMPORTANCE: 10 CFR 100.21, "Reactor Site Criteria," of Title 10 of the Code of Federal Regulations states "The population center distance, as defined in § 100.3, must be at least one and one-third times the distance from the reactor to the outer boundary of the low population zone". In applying this guide, the boundary of the population center shall be determined upon consideration of population distribution. Political boundaries are not controlling in the application of this guide. Part 100.21, "Reactor Site Criteria," of Title 10 of the Code of Federal Regulations states that the population center distance is the distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents.

RISK: The NRC staff will evaluate if a population center (a populated area with 25,000 or more people) is within one and one-third times the distance from the reactor to the outer boundary of the low population zone (LPZ). The LPZ is an area immediately surrounding the exclusion area which contains residents. The LPZ can vary by site but it is usually defined as a 2 mile (3.2 km) radius. If a population center is closer than one and one-third times this distance, the NRC may want to look at alternative sites.

EVALUATION:

Acceptable Site

Challenged Site Requiring Further Evaluation

Site Not Suitable

DISCUSSION: The potential impacts to the population in the region must be reasonable and appropriate. Locating reactors away from population 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.

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Site Type - The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield“, or “existing nuclear power plant” site. The evaluation should identify the unique applicability of site type-related differences, if any, for the treatment of this issue. In addition, the evaluation should take into consideration existing data and analyses that might be available, for example, in the case of an existing nuclear site or, perhaps, a “Brownfield site.” In these cases the population center analysis may have been previously completed and evaluated; whereas a population center analysis will not have been completed for a Greenfield site.

Evaluation Criteria - A population center must be at least one and one-third times the distance from the reactor to the outer boundary of the low population zone. A population center is defined as a densely populated center containing more than 25,000 residents. A Low Population Zone is designated by the applicant and is the area immediately outside the exclusion area boundary to a distance that reasonable and appropriate protective measures could be taken in the event of a serious accident. The LPZ is usually a 2 mile (3.2 km) radius from the site center point.

An Acceptable Site meets these criteria by not having any population centers within 3 miles (4.8 km).

A Challenged Site (Requiring Further Evaluation) occurs if there is a population center within 3 miles (4.8 km).

A Site Not Suitable evaluation occurs when a population center is identified within one and one third times the distance from the reactor center to the outer boundary of the LPZ.

Population Center Analysis - Population center information can be obtained from the U.S. Census Bureau. Any town or urban area within 3 miles (4.8 km) from the site should be evaluated and projected to at least 5 years after the initial licensing date. If any urban areas contain more than 25,000 people at this distance the site fails to meet the criteria.

Risk - The NRC staff will review the population center analysis to determine if the site meets the criteria. If there is evidence that the site does not meet the population center criteria the NRC will want to find an alternate site.

Risk Mitigation - If the criterion is not met, a dose analysis could be performed to find the radius in which an individual would not receive a radiation dose in excess of 25 rem TEDE and revise the LPZ. Also, a GIS based population center analysis, with precise population projections, could be performed to see if the threshold distance could be revised.

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REFERENCES:

1. 10CFR100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance"
2. 10CFR100.21, "Non-Seismic Siting Criteria"
3. 10CFR100.3, "Definitions"
4. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)"
5. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations"
6. U. S. Nuclear Regulatory Commission, NUREG-1555, SRP 2.1, "Station Location"
7. U. S. Nuclear Regulatory Commission, NUREG-1555, SRP 2.5.1, "Demography"
8. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.1.1, "Site Location and Description"
9. U. S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.1.3, "Population Distribution"

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ENVIRONMENTAL CHARACTERISTICS TEMPLATES

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ENVIRONMENTAL CHARACTERISTICS TEMPLATES

ECOLOGY

Terrestrial Ecology

Aquatic Ecology

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SITE CHARACTERISTIC: ENVIRONMENTAL / ECOLOGY / Terrestrial Ecology

DESCRIPTION: The potential for adverse impacts at a proposed site may involve any or all of numerous factors which may cause alterations to local faunal or floral communities attributable to removal or alteration of upland or wetland habitats.

IMPORTANCE: Federal regulations including 10 CFR 51.10 require compliance with the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA), i.e. federal agencies are charged with ensuring actions under their jurisdiction do not jeopardize or adversely modify critical habitat of federally listed species and consulting with the United States Fish and Wildlife Service (USFWS) and other appropriate agencies on the protection of threatened and endangered (T&E) species. In addition to the ESA, Draft Regulatory Guide DG-4015 (Proposed Revision 1 of Regulatory Guide 4.2, Supplement 1, dated September 2000, Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications) states that the Migratory Bird Treaty Act (MBTA) and Bald and Golden Eagle Protection Act (BGEPA) must be assessed. The ESRP (NUREG-1555) states a thorough description of the on-site and off-site potential impacts from construction and operation of a power plant should be performed. NRC Regulatory Guide 4.7 states *“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.”* The Endangered Species Act, 16 USC 1531, requires that any action authorized, funded, or carried out by a federal agency in the U.S. must not likely jeopardize the continued existence of any listed endangered or threatened species or result in the destruction or adverse modification to critical habitat.

RISK: The NRC staff will review the terrestrial ecology discussion with the intention of measuring the temporal and spatial scale of temporary and permanent impacts. Large losses of habitat (upland or wetland), adverse impacts to federally or state protected species and/or their associated habitat, inability to sufficiently mitigate for impacted wetlands, or the inability to demonstrate adequate environmental protection may result in the rejection of the site for the nuclear power plant application. The risk of insufficient quality or quantity of data is magnified if state or federal T&E species are involved. Care should be exercised when making presence / absence species determinations. An “absence” determination will require significant amounts of high quality evidence.

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EVALUATION:

Overall Site Evaluation for Terrestrial Ecology:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION:

The overall evaluation of Terrestrial Ecology is indicated above. This evaluation is based on the individual criteria evaluations, as discussed and indicated in "Evaluation Criteria" below. The overall evaluation should reflect the worst-case of the individual evaluation(s).

Site Type - The evaluation should recognize the type of site being evaluated, i.e., a "Greenfield," "Brownfield" or "existing nuclear power plant" site. Many of the parameters discussed below may have already been addressed for an industrial site or one with an existing power plant. The intensity of each assessment and the quality of data required for a positive site selection will vary with the type of site and its proximity to other site of local importance. Potential sites located in "greenfields" may require more investigation to determine biotic communities and potential impacts while existing power plant sites may possess extensive data.

Risk Mitigation - Specific information about the site in question may not be available but high quality data from comparable areas in proximity may be used to assess the site. Alternatively, the absence of data from a given location can be mitigated by initiating intensive studies targeting the species or community in question. Biological impacts may be mitigated by demonstrating a limited spatial or temporal effect or through agreements and permits with affected state and federal agencies. Localized effects, while significant, may not be measurable a short distance from the site and thus produce a small or negligible regional-scale impact. Careful planning and modifications to the plant footprint may avoid wetlands and other sensitive habitat. Unavoidable wetland losses may be mitigated through various strategies coordinated through the local Corps of Engineers office. Commitments to restoring temporary disturbances to a natural state may be necessary.

Evaluation Criteria -

(1) Removal or Alteration of Upland Habitat:

Examine the size and location of the entire facility including all off-site facilities to ensure that unnecessary amounts of terrestrial upland habitat are not lost or impacted permanently. Determine the ecological value by assessing the function of the different habitat types associated with the proposed site. Determine if any preferential habitat for resident or transient species may be located in the proposed location. Evaluate the habitats lost to

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construction in terms of the surrounding area to determine the rarity of habitat type. Determine if any critical habitat has been designated in the area.

The site may be classified as “Acceptable Site” for Removal or Alteration of Upland Habitat if no preferential habitat for resident or transient species will be permanently impacted and no designated critical habitat for state- or federally-listed species will be impacted.

The site may be classified as “Challenged Site Requiring Further Evaluation” for Removal or Alteration of Upland Habitat if large amounts of preferential habitat for resident or transient species may be temporarily impacted but cost-effective mitigation efforts will be made.

The site may be classified as “Site Not Acceptable” for Removal or Alteration of Upland Habitat if large amounts of preferential habitat for resident or transient species will be permanently impacted with no mitigation efforts (or mitigation efforts become cost-prohibitive) or if designated critical habitat will be impacted.

- Evaluation:** **Acceptable Site**
 Challenged Site Requiring Further Evaluation
 Site Not Suitable

(2) Removal or Alteration of Wetland Habitat

Examine the proposed location for wetlands that the United States Army Corps of Engineers (USACE) could potentially assert jurisdiction over. The USACE technical guidelines for defining wetlands are contained in the USACE 1987 Wetland Delineation Manual (USACE 1987). Examine National Wetland Inventory Maps along with Federal Emergency Management Agency (FEMA), aerial, soil, and topographic maps for the potential occurrence of wetlands on the proposed location. Ground-truthing of these potential sites is essential. If wetlands must be impacted, the avoidance-minimization- mitigation sequence must be coordinated through the USACE and §404 permit process.

The site may be classified as “Acceptable Site” for Removal or Alteration of Wetland Habitat if jurisdictional wetland habitat will not be impacted.

The site may be classified as “Challenged Site Requiring Further Evaluation” for Removal or Alteration of Wetland Habitat if jurisdictional wetland habitat will be impacted but cost-effective mitigation efforts will be made to compensate for the loss.

The site may be classified as “Site Not Acceptable” for Removal or Alteration of Wetland Habitat if jurisdictional wetland habitat will be

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impacted but mitigation efforts will not be made (or mitigation efforts become cost-prohibitive).

- Evaluation:** **Acceptable Site**
 Challenged Site Requiring Further Evaluation
 Site Not Suitable

(3) Threatened and Endangered Species

Look for state and federal T&E species, migratory bird species, bald and golden eagles, or potential habitat that would support them that may occur in or around the proposed site. Research the state or local sensitive/rare species that possibly occur or have potential habitat in the proposed location. Determine if any preferential habitat may be located in the proposed location. Determine if any critical habitat has been designated in the area. Look for state and federal agency reports, university and peer-reviewed articles on habitat preferences and requirements for all listed species that may be found on the plant site.

The site may be classified as “Acceptable Site” for Threatened and Endangered Species if T&E, protected bird species, and sensitive/rare species potential habitat or designated critical habitat will not be impacted.

The site may be classified as “Challenged Site Requiring Further Evaluation” for Threatened and Endangered Species if T&E, protected bird species, and sensitive/rare species potential habitat will be impacted but cost-effective mitigation efforts will be made.

The site may be classified as “Site Not Acceptable” for Threatened and Endangered Species if T&E, protected bird species, and sensitive/rare species potential habitat will be impacted and mitigation efforts will not be made (or mitigation efforts become cost-prohibitive) or if designated critical habitat will be impacted.

- Evaluation:** **Acceptable Site**
 Challenged Site Requiring Further Evaluation
 Site Not Suitable

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REFERENCES:

1. 10 CFR 51.10, "Application of Regulations of Council on Environmental Quality"
2. 16 USC 1531, "The Endangered Species Act"
3. U. S. Nuclear Regulatory Commission, Draft Regulatory Guide DG-4015 (Proposed Revision 1 of Regulatory Guide 4.2, Supplement 1, dated September 2000) Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications
4. U. S. Nuclear Regulatory Commission, NUREG-1555, "Environmental Standard Review Plan"
5. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability for Nuclear Power Stations," April 1998
6. USACE 1987, Corps of Engineers, "Wetland Delineation Manual"

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SITE CHARACTERISTIC: ENVIRONMENTAL / ECOLOGY / Aquatic Ecology

DESCRIPTION: The following discussion is relative only to those plant designs requiring cooling water. The potential for adverse impacts at a candidate site may involve any or all of numerous factors which may cause alterations to local faunal communities attributable to entrainment / impingement, temperature shock, changes in flow regime, removal or alteration of habitat, or changes in behavior related to heated effluents which may affect migration or spawning. Contamination by conventional pollutants is not likely but NPDES controls will be in-place to ensure no release of chemicals in concentrations that would be detrimental to aquatic life.

IMPORTANCE: 33 U.S.C. 1251 (Federal Water Pollution Control Act) declares that it is the goal of the Act to restore and maintain the chemical, physical and biological integrity of the nation's waters. Various Federal regulations including 10 CFR 51.10 require Federal agency compliance with NEPA. The ESRP (NUREG-1555) states a thorough assessment of on-site and off-site potential impacts from construction and operation of a plant must be included in any application. NRC Regulatory Guide 4.7 states *"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."* Regulatory Guide 4.7 also states *"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"*. The Endangered Species Act, 16 USC 1531, as amended, requires that any action authorized, funded, or carried out by a federal agency in the US must not likely jeopardize the continued existence of any listed endangered or threatened species or result in the destruction or adverse modification to critical habitat. For plants using ocean water for cooling, The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.) establishes the goal and policies of Congress relating to the protection and management of commercial fisheries resources including essential habitat. The Marine Mammal Protection Act, with limited exceptions, prohibits the take of marine mammals and defines measures intended to promote the replenishment of depleted stocks.

RISK: The NRC staff will review the aquatic discussion in the COLA with the intention of measuring the temporal and spatial scale of temporary and permanent impacts. The risk of unacceptably large losses of habitat, individuals of any species protected by state or federal regulation, or changes in local biotic assemblages, or the inability to demonstrate sufficient environmental protection may

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result in the rejection of the site for the nuclear plant application. The risk of insufficient quality or quantity of data is magnified if state or federal T&E species are involved. Care should be exercised when making presence / absence determinations. Significantly more high quality evidence will be required to make an “absence” determination.

EVALUATION:

Overall Site Evaluation for Aquatic Ecology:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION:

The overall evaluation of Aquatic Ecology is indicated above. This evaluation is based on the individual criteria evaluations, as discussed and indicated in “Evaluation Criteria” below. The overall evaluation should reflect the worst-case of the individual evaluation(s).

Site Type - The evaluation should recognize the type of site being evaluated, i.e., a “Greenfield,” “Brownfield or “existing nuclear power plant” site. Many of the parameters discussed below may have already been addressed for an industrial site or one with an existing power plant. The intensity of each assessment and the quality of data required for a positive site selection will vary with the type of site and its proximity to other sites of local importance. Potential sites located in “greenfield” areas may require more investigation to determine biotic communities and potential impacts while existing power plant sites may possess extensive data.

Risk Mitigation - Specific information about the site in question may not be available but high quality data from comparable areas in proximity may be used to assess the site. Alternatively, the absence of data from a given location can be mitigated by initiating intensive studies targeting the species or community in question. Biological impacts may also be mitigated by demonstrating a limited spatial or temporal effect. Localized effects, while significant, may not be measurable a short distance from the site and thus produce a small or negligible regional-scale impact. Careful site layout can avoid most (if not all) channels through the site. Mitigation for those that cannot be avoided will need to be coordinated through the Corp of Engineers.

Evaluation Criteria -

(1) Entrainment / Impingement:

Determine the potential for excess entrainment / impingement by examining the composition and density of impingable size fish. Examine the spawning patterns and preferred habitat of local fish

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species of economic or recreational importance to determine the potential density and composition of the plankton community. Look for entrainment / impingement studies from other facilities in the area if one does not exist for the potential site. Look for university or state agency fish and plankton surveys. If data are older than 5 years, explain why the studies would or would not be relevant for assessing the effects of present and projected future plant operation over the term of license renewal. For example, demonstrate that both the potentially affected resources and the effect of the plant on them have remained and can be expected to remain unchanged over the term of license renewal. Ensure that the intake design and water demand are CWA 316(b) compliant. These criteria are more heavily weighted if T&E species or NRC "important" species are documented in the area. The potential plant should not cause or contribute to measurable decreases in fish numbers through direct mortality or changes in reproductive success.

The site may be classified as "Acceptable Site" for Entrainment / Impingement if

- (1) the intake is not located downstream of preferred spawning habitat of any commercially or recreationally important species,
- (2) valid studies suggest no significant presence of eggs or plankton in the water column, and
- (3) no state- or federally-listed species are known to inhabit the area surrounding the intake.

The site may be classified as "Challenged Site Requiring Further Evaluation" for Entrainment / Impingement if

- (1) spawning areas for commercially or recreationally important species may be located upstream of the intake,
- (2) either appropriately sized screens or a fish return system is not included in the design package, or
- (3) at least one state- or federally-listed species has a historic distribution that includes the area surrounding the intake but its current occurrence is uncertain.

The site may be classified as "Site Not Acceptable" for Entrainment / Impingement if

- (1) significant spawning areas for commercially or recreationally important species are known to occur in the area of the intake,
- (2) neither plankton screens nor a fish return system is included in the design package, or
- (3) at least one state- or federally-listed species is known to occur in the area of the intake.

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- Evaluation:** **Acceptable Site**
 Challenged Site Requiring Further Evaluation
 Site Not Suitable

(2) Temperature Shock:

Determine the ΔT effect of the thermal effluent on the receiving water through mass balance equations or hydrologic modeling. Determine the size and duration of the plume and compare those results to the Water Quality Standards applicable to the site. Consider the effect a diffuser may have on the size and duration of the thermal plume. Consider the thermal tolerances of the most sensitive local fish and any recreational / commercial fisheries in the area. Determine if the thermal plume could block migration pathways. Look for university or state agency fish surveys. Use local references when possible to determine thermal tolerances. If local references are not available, look for thermal tolerance data from areas of comparable climate and seasonality. Look for peer-reviewed journal articles relating to behavior of target species related to thermal plumes. The potential plant should not cause or contribute to measurable decreases in fish numbers through direct mortality or changes in the reproductive success.

The site may be classified as “Acceptable Site” for Temperature Shock if

- (1) modeling efforts have demonstrated that the effluent will comply with state Water Quality Standards for ΔT and the maximum thermal limit for the receiving waters at the appropriate point of compliance (e.g. mixing zone boundary) at regulatory low flows and
- (2) the thermal plume is not expected to cross an area inhabited by a thermally-sensitive species.

The site may be classified as “Challenged Site Requiring Further Evaluation” for Temperature Shock if

- (1) modeling efforts have demonstrated that a diffuser may be necessary to modify the shape or areal extent of the plume to comply with Water Quality Standards at regulatory low flows or
- (2) some temperature-sensitive species may be found in the area of the discharge and the thermal plume.

The site may be classified as “Site Not Acceptable” for Temperature Shock if

- (1) modeling efforts have demonstrated that the ratio of the heated effluent to the receiving water regulatory low flows will not allow sufficient mixing to reduce the ΔT and the maximum

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thermal limit for the receiving water to a level that will comply with Water Quality Standards or

- (2) a significant population of at least one thermally-sensitive species is documented in the area of the discharge.

- Evaluation:** **Acceptable Site**
 Challenged Site Requiring Further Evaluation
 Site Not Suitable

(3) Changes in Flow Regime:

Determine the ratio of intake to mean annual flow, regulatory low flow and extreme low flow (life-of-the-plant recurrence) if one can be determined. Look for the nearest USGS gauge or other reliable flow monitoring site. Determine the effect of water loss (plant consumption) on downstream users including wildlife. Examine the size and location of the intake and discharge structures to ensure that no counter-currents, diversions or scouring will be induced by the structures. The potential plant should not adversely impact the flow regime of the receiving water or water availability for existing withdrawals.

The site may be classified as “Acceptable Site” for Changes in Flow Regime if

- (1) the withdrawal is expected to meet 316(b) requirements at all flows and
(2) the intake and discharge structures are not expected to create changes in the flow that could adversely impact the surrounding substrate (counter-currents or eddies).

The site may be classified as “Challenged Site Requiring Further Evaluation” for Changes in Flow Regime if

- (1) the withdrawal exceeds 316(b) requirements during some dry periods creating a need for temporary cessation of operations or
(2) the intake or discharge structures demonstrate a potential for localized substrate disturbance.

The site may be classified as “Site Not Acceptable” for Changes in Flow Regime if

- (1) the withdrawal is expected to exceed 316(b) requirements often enough to prevent cost-effective operation of the plant or
(2) the intake or discharge structures are expected to create significant substrate disturbance and resuspension of sediments leading to habitat loss and exceedances of Water Quality Standards (e.g. total suspended solids, turbidity, etc).

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- Evaluation:** **Acceptable Site**
 Challenged Site Requiring Further Evaluation
 Site Not Suitable

(4) Removal or Alteration of Habitat:

Examine site topographic maps and the proposed location for water of the U.S. (stream, intermittent channel, etc) that the United States Army Corps of Engineers (USACE) could potentially assert jurisdiction over. Examine the size and location of the intake and discharge structures to ensure that significant amounts of aquatic habitat are not lost. Look for state and federal threatened and endangered species that may have specific spawning, hunting, or refuge habitat in the area. Examine the structure and location of the intake and discharge structures to ensure that no counter-currents or scouring will be induced by the structures. Determine if sedimentation may become an issue requiring periodic dredging and disturbance and resuspension of local substrate. Look for state and federal agency reports, university, and peer-reviewed articles on local habitat preferences and requirements. Determine if the heated effluents will cause a change in the habitat by creating a temperature regime less favorable to native species. The potential plant should not cause or contribute to changes to the local vegetative community that result in measurable decreases in fish numbers through direct mortality or changes in the reproductive success.

The site may be classified as “Acceptable Site” for Removal or Alteration of Habitat if

- (1) the intake or discharge structures are not designed or placed in such a manner that significant amounts of breeding, foraging, or nursery habitat are lost and
- (2) construction or operation of the intake or discharge structures create habitat more favorable for native species.

The site may be classified as “Challenged Site Requiring Further Evaluation” for Removal or Alteration of Habitat if

- (1) the intake or discharge structures are designed or placed in such a manner that some breeding, foraging, or nursery habitat are temporarily lost but cost-effective mitigation measures may be employed or
- (2) construction or operation of the intake or discharge structures create habitat more favorable for non-native species but cost-effective management strategies are available.

The site may be classified as “Site Not Acceptable” for Removal or Alteration of Habitat if

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- (1) the intake or discharge structures are designed or placed in such a manner that significant amounts of breeding, foraging, or nursery habitat will be lost or
- (2) construction or operation of the intake or discharge structures create habitat more favorable for non-native species and cost-effective management strategies are not available.

- Evaluation:** **Acceptable Site**
 Challenged Site Requiring Further Evaluation
 Site Not Suitable

(5) Changes in Behavior Related to Heated Effluents:

Examine temperature tolerances and preferences of locally important commercial or recreational species. Look for peer-reviewed journal articles relating to behavior of target species related to thermal plumes. Determine if the thermal plume could intersect important or rare habitat (including spawning habitat) that could support locally important commercial or recreational species or T&E species. Determine if the thermal plume could be block migration pathways or interfere with “spawning runs”. Determine if removal of the plume (during shutdown) could adversely affect species accustomed to the temperature. The potential plant should not release heated effluents in quantities sufficient to significantly alter the behavior of fauna in the area.

The site may be classified as “Acceptable Site” for Changes in Behavior Related to Heated Effluents if there are no demonstrated migratory pathways through the area around thermal plume.

The site may be classified as “Challenged Site Requiring Further Evaluation” for Changes in Behavior Related to Heated Effluents if historical migratory pathways exist but the occurrence of the migrating species in the area of the plant is no longer certain.

The site may be classified as “Site Not Acceptable” for Changes in Behavior Related to Heated Effluents if thermally-sensitive migrating species are demonstrated to be in the area of the thermal plume at least part of the year.

- Evaluation:** **Acceptable Site**
 Challenged Site Requiring Further Evaluation
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REFERENCES:

1. 10CFR51.45, "Environmental Report"
2. 10CFR51.10, "Application of Regulations of Council on Environmental Quality"
3. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.2, "Environmental Report"
4. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability for Nuclear Power Stations"
5. U. S. Nuclear Regulatory Commission, NUREG-1555, "Environmental Standard Review Plan"
6. 33USC1251, "Federal Water Pollution Control Act (Clean Water Act)"
7. Entergy Nuclear, "Site Selection Criteria Guidelines for an Early Site Permit"
8. U. S. Nuclear Regulatory Commission, Draft Regulatory Guide DG-4015, Proposed Revision 1 of Regulatory Guide 4.2, Supplement 1, dated September 2000, "Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications."

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ENVIRONMENTAL CHARACTERISTICS TEMPLATES

LAND USE

Transmission Corridors and Transportation Routes

Historic/ Archeological/Cultural Resource Issues

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SITE CHARACTERISTIC: ENVIRONMENTAL / LAND USE / Transmission Corridors and Transportation Routes

DESCRIPTION: In the process of selecting a candidate site, transmission corridor, or transportation route, the potential for negatively impacting land use on the site, in the vicinity, or in the region, must be considered. These include:

- the public’s aesthetic experience associated with nearby sensitive areas or viewsheds
- conflicts with existing or intended public land use objectives, i.e. local recreational use, mineral resource extraction, national parks, Indian tribal lands and reservations, etc.
- disruption of lands dedicated to unique agricultural economic markets, such as growing specialty crops and the disturbance of prime agricultural lands

IMPORTANCE: 10 CFR 51.71(d) requires that “consideration will be given to compliance with environmental quality standards and requirements that have been imposed by Federal, State, regional and local agencies having responsibility for environmental protection, including applicable zoning and land-use regulations.” This would include Indian tribal lands or reservations. 10 CFR 51, Appendix A(7) discusses the presentation of analysis should also be included for alternative candidate sites.

NRC Regulatory Guide 4.7 states that any potential conflicts between governing land use plans and the potential site should be examined and resolved through consultation. Candidate sites located “in areas uniquely suited for growing specialty crops may be considered a type of land conversion involving unacceptable economic dislocation.” Further, “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.”

According to NUREG-1555, ESRP 2.2.2, the above mentioned code of federal regulations are the “acceptance criteria for the review of land use in transmission line corridors, access corridors, and other offsite areas that will be modified for the sole purpose of supporting construction or operation of the proposed project.”

RISK: The NRC Staff will assess the significance of direct and indirect environmental effects of plant construction to site, vicinity, and regional land use. Should potential conflicts with intended land use be identified, and no satisfactory means of mitigation of adverse environmental impacts presented or viable alternative sites offered, this could result in the rejection of the application. Conflicts could include construction on a candidate site and

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potential negative impact to the aesthetics of a neighboring special use property, or construction that would directly alter, for the short-term and/or long-term, the use of the designated land, neighboring public lands, Indian lands, or specialty crop lands in opposition to plans and policies of the governing bodies.

EVALUATION:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION:

Staff should perform a detailed analysis ascertaining past and current land use for the candidate site, including establishing ownership history, ownership of mineral resources, and historical use or intended land use within a proposed site boundary. A USGS land-use classification of the site should be performed. Any egress limitations or restrictions of the site should be identified. The information in these records would be used to evaluate initial site suitability, and subsequent assessment of the relationship of the site location with respect to vicinity and regional land use practices and policies.

Site Type – The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield,” or existing nuclear power plant site. In addition, the evaluation should take into consideration existing data and analyses that might be available, for example, in the case of an existing nuclear site or, perhaps, a “Brownfield site.” In a “Brownfield” or “existing nuclear” example, the site may have already been so altered that the impact to area aesthetics, disruption of unique soil types or specialty crops, or potential impacts to neighboring public land use, may have already been identified. Impacted agencies’ concerns may have been taken into consideration, and mitigation procedures already adopted for these types of reuse sites. Whereas, more intensive research and analysis of potential conflicts could be necessary if dealing with a “Greenfield” site where previous history has not been established.

Evaluation Criteria - For each of the analysis parameters, evaluation criteria is based on the Environmental Standard Review Plan (NUREG-1555) and guidance rationale from NRC Regulatory Guide 4.7, Rev 2.

An Acceptable Site occurs if no conflicts between the applicant’s proposed facility and the objectives of Federal, regional, State, and local (and in the case of proposed location on a reservation, Native American tribal) land-use plans are identified.

A Challenged Site (Requiring Further Evaluation) occurs if there are or are likely to be conflicts between the applicant’s proposed site and the surrounding identified land use patterns.

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A Site Not Suitable evaluation occurs when potential conflicts with local land use are identified and no satisfactory means of mitigation is foreseeable.

Land Use analysis performed for each of the parameters, which include aesthetic impacts, the identification of unique soils that may be disrupted, and potential impact to local public use lands, should consider the following steps:

- Identify any special land use (e.g., culturally sensitive buildings, recreational facilities, agricultural use, and prime farmland and unique soils) that could be affected by the site. This information can be obtained from local and state zoning and planning publications and the 2007 Census of Agriculture.
- Determine the regional sensitive land use (e.g., hospitals, residences, State, Federal, and local parks, Wilderness areas, Native American lands, local culturally sensitive lands, and sensitive viewsheds). This information can be obtained from local Chambers of Commerce publications, National Park Service (NAGPRA), and local and state publications.
- Identify the public use policy, standard, guideline and/or plan that may provide public or regulatory oversight of the issue.
- Consider the collected information and evaluate the candidate site accordingly. It may be useful to estimate the potential geographic and temporal extent and magnitude of the impact.

Risk – While the majority of land use patterns can be identified from publicly available data, some information will only be available by consultation with local residents, Native American tribes, and the various state and local agencies. Thus, some impacts, not identified in this level of review, could arise. Also, some of the mitigation efforts could be costly and time consuming.

Risk Mitigation – RG 4.7 states “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.” According to NUREG-1555, if upon evaluation of impacts a judgment is made that the “impact is adverse, cannot be successfully mitigated, and is of such magnitude that it should be avoided,” it would be necessary to discuss alternative designs and subsequently re-address the issue with the appropriate agency to find an alternative mitigation option.

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REFERENCES:

1. 10 CFR 51.71(d), "Draft Environmental Impact Statement"
2. 10 CFR 51, Appendix A(7), "Environmental Consequences and Mitigating Actions"
3. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," April 1998
4. U. S. Nuclear Regulatory Commission, NUREG-1555 ESRP 2.2, "Land"
5. U. S. Nuclear Regulatory Commission, NUREG-1555 ESRP 4.1, "Land-Use Impacts"
6. U. S. Nuclear Regulatory Commission, NUREG-1555 ESRP 5.1, "Land-Use Impacts"
7. U. S. Nuclear Regulatory Commission, NUREG-1555 ESRP 5.8, "Socioeconomic Impacts"
8. U. S. Nuclear Regulatory Commission, NUREG-1555 ESRP 9.3, "Alternative Sites"

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SITE CHARACTERISTIC: ENVIRONMENTAL / LAND USE / Historic/Archeological/Cultural Resource Issues

DESCRIPTION: A historic property is "...any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places (NRHP) maintained by the Secretary of the Interior (36 CFR 63). This term includes artifacts, records, and remains that are related to and located within such properties. The term includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization that meet the National Register Criteria." These criteria are listed in 36 CFR 60.4. Historic properties typically include prehistoric archaeological sites; historic archaeological sites; aboveground historic sites manifested by standing structures such as houses, barns, or grist mills (usually more than 50 years old); and traditional cultural properties. A traditional cultural property is one that is eligible for or listed on the NRHP because of its association with the cultural practices or beliefs of a living community that (a) are rooted in that community's history (b) are important in maintaining the continuing cultural identity of the community (e.g., native American sacred lands, raw material gathering sites, ritual areas, and ethnic neighborhoods). Even if such a property is not eligible for or listed on the NRHP, its traditional value to an ethnic group may still warrant its protection as a traditional cultural property. A historic cemetery that meets the NRHP criteria is also a historic property, but as a general rule, most historic cemeteries are not considered to be historic properties. However, they are still important because most state and local governments have laws, regulations, and ordinances in place to protect cemeteries from harm, and some of these requirements involve criminal penalties. In the site-selection process, evaluation of a candidate site is necessary to avoid selection of a site where future nuclear power plant construction and operations would disturb or destroy historic properties and cemeteries.

IMPORTANCE: For a federal undertaking, such as issuing a construction permit or operating license for a new nuclear power plant, the National Historic Preservation Act of 1966 (Section 106) and the federal regulations in 36 CFR 800 require the lead federal agency [U.S. Nuclear Regulatory Commission (NRC)] to define the areas of potential effect (APE) on historic properties, identify historic properties within the APE, assess the potential adverse effects of the undertaking on any historic properties that are present, and mitigate these adverse effects. Issuance of a construction permit or operating license would result in a nuclear power plant construction and operations activities that could result in such adverse if any historic cemeteries are present within defined APEs on or near the site.

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RISK: Available documents and records must be reviewed to determine whether any historic properties or cemeteries are present on or near a candidate site. The presence of historic properties or cemeteries on a candidate site or in close proximity to it may result in its rejection for construction of a new nuclear power plant.

EVALUATION:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION: Perform a detailed archival search for existing documents and records pertinent to the identification of prehistoric archaeological sites; historic archaeological sites; aboveground historic sites (standing buildings and structures), historic districts, historic objects, traditional cultural properties, and cemeteries on and near a candidate site for a new nuclear power plant. The information in these records will be used to evaluate candidate site suitability with regard to historic properties.

Site Type – The evaluation should identify the type of candidate site that is being evaluated (i.e., Greenfield site, Brownfield site, an existing nuclear power plant site, or an open field site that is known to have deeply and extensively disturbed soil). It is important to factor site type into the analysis because it is highly probable that a Greenfield site has never been the subject of past cultural resource studies. This means that historic properties and cemeteries may be present on or near the site, but information on them is unlikely to be present in any existing documents. To a more limited extent, the same may be true of a Brownfield site if its past use involved only private sector activities. In most states, private sector sites have not been subject to federal, state, or local cultural resource survey and management requirements. Private sector Brownfield sites with extensive past construction and open field sites known to have widespread and deeply disturbed soils have a low probability of containing intact historic properties or cemeteries because they have been disturbed or destroyed by past earthmoving and construction activities. Federal Brownfield sites and existing nuclear power plant sites have typically been subject to past cultural resource studies or record reviews, and written reports are usually available.

Evaluation Criteria – The candidate site evaluation criteria for historic properties are as follows:

The site may be classified as a Fully Acceptable Site if it has been studied for cultural resources and available documents show that either no historic properties or cemeteries are present within the site boundary or they are present in locations where impacts are known to be avoidable. If a site located outside of a floodplain has not been studied for cultural resources but the on-site soils have

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been disturbed extensively and to depth so that no intact historic properties would be present, the site is fully acceptable. Furthermore, under both of those circumstances, no historic properties (aboveground historic sites and traditional cultural properties) or cemeteries are present outside of the site boundary at locations where they would be adversely impacted visually or by noise. However, a candidate site would be a fully acceptable if such off-site visual and noise impacts were known to be avoidable. An NRHP-eligible or listed archaeological site cannot be impacted visually or by noise because it is buried underground.

The site may be classified as a Challenged Site Requiring Further Evaluation under two circumstances: 1) A site has not been studied for cultural resources in the past, which means that no historic property or cemetery documentation is available for the site or the nearby areas surrounding it; 2) A site has been studied for cultural resources in the past and documentation is available. The available documentation indicates that archaeological sites, aboveground historic sites, traditional cultural properties, or cemeteries are present within the site boundary and/or outside the site boundary at locations where they would be impacted visually or by noise. However, their current NRHP status (recommended eligible, eligible, or listed) is either unknown because it has never been assessed or it is in doubt because of previous "ineligible" recommendations that were not supported by systematic shovel testing.

The site may be classified as a Site Not Suitable when historic properties or cemeteries are known to be present within the site boundary and impacts upon them are known to be unavoidable. It also applies when historic properties (aboveground historic sites or traditional cultural properties) or cemeteries are present outside of the site boundary at locations where they would be adversely impacted visually or by noise and such impacts are known to be unavoidable. An NRHP-eligible or listed archaeological site cannot be impacted visually or by noise because it is buried underground.

The Environmental Standard Review Plan (NUREG-1555) and NRC Regulatory Guide 4.2 provide insight as to areas of review by the NRC Staff and should be consulted as appropriate to ensure that the evaluation is sufficiently comprehensive. In addition, NRC Regulatory Guide 4.7 should be reviewed prior to performing the analysis.

Analysis

Five sequential steps are required to complete the historic properties analysis. The first step is to identify and acquire the existing documentation relevant to the candidate site, which includes old maps; archaeological and historic site survey files; architectural inventory files; environmental reports, environmental

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assessments, and environmental impact statements; cultural resource survey and excavation reports, and any other pertinent documentation. State archaeological and historic site survey files, the NRHP, and any existing state and local registers of historic places should be the primary document sources. Other excellent sources are local urban planning offices, local historical societies, the historical room in local public libraries, and the site owner(s). The second step is to review the acquired documents to identify cultural resource information specific to the land within the boundary of the candidate site and on surrounding land outside of the site boundary (up to a 10-mile (16 km) radius of the reactor center point, as practical, and depending on local terrain, ground cover vegetation, and the prospects for visual and noise impacts on aboveground historic sites, traditional cultural properties, and cemeteries). For the third step, identify and locate the cultural resources (e.g., archaeological sites, aboveground historic sites, traditional cultural properties, and cemeteries) that have been previously found within the boundary of the candidate site and in the surrounding area outside of the site boundary. Fourth, identify any cultural resources (e.g., archaeological sites, aboveground historic sites, traditional cultural properties, or cemeteries) that have been previously recommended as eligible, determined as eligible, or listed on the NRHP or state/local registers. These are defined as historical properties. Those that are either eligible for or listed on state/local registers are also of concern to the NRC and should be regarded as historic properties too for purposes of this historic properties analysis. For the last step, considering the collected information, site type, past soil disturbance, and risk factors, evaluate the candidate site according to the above-listed site evaluation criteria.

Risk – One basic risk is associated with performing an historic properties analysis solely on the basis of already existing documentation. Quite often, such documentation on a candidate site is old and incomplete. This means that a previously unidentified historic property can be present on a site, but its presence will be missed in the analysis, which can lead to an inaccurate candidate site evaluation. Awareness of this risk is particularly important when evaluating Greenfield sites. In reality, the only way to thoroughly and confidently assess a candidate site for the presence of historic properties and cemeteries is to implement an on-the-ground Phase I intensive survey with systematic shovel testing and Phase II archaeological testing (if necessary).

Risk Mitigation - A Phase I intensive field survey with systematic shovel testing can be implemented in the anticipated candidate site APEs to identify whether any historic properties or cemeteries are present. If none are present, the candidate site is considered a

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Fully Acceptable Site, and the SHPO will clear it for plant construction and operations. If human cultural remains (e.g., an archaeological site) are found in the APEs during the Phase I intensive survey, but the survey data are inadequate to determine if it qualifies as a historic property, Phase II testing will be necessary to gather the information needed to do so. If a historic property or cemetery is identified in Phase I or Phase II field investigations, the site can be converted into a Fully Suitable Site in two ways: 1) Potential impacts on the discovered historic property or cemetery can be mitigated through Phase III data recovery operations or cemetery removal in accordance with state and local laws. Such operations tend to be expensive and time-consuming; 2) Potential impacts on a historic property or cemetery can be intentionally avoided during design, construction, and operation of the proposed plant. In most cases, the SHPO prefers avoidance over Phase III data recovery because Phase III data recovery and cemetery removal involve controlled destruction of the historic property or cemetery whereas avoidance preserves these resources for future generations. However, avoidance may not be technically feasible on some candidate sites, depending on plant design parameters and the unique physical characteristics of the candidate site. The appropriateness of mitigation or avoidance must be assessed on a case-by-case basis.

REFERENCES:

1. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Stations"
2. U. S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations"
3. U. S. Nuclear Regulatory Commission, NUREG-1555, ESRP 2.5.3, "Historic Properties"
4. U. S. Nuclear Regulatory Commission, NUREG-1555, ESRP 4.1.3, "Historic Properties"
5. U. S. Nuclear Regulatory Commission, NUREG-1555, ESRP 5.1.3, "Historic Properties"
6. 16 USC 470 et seq, "National Historic Preservation Act of 1966"
7. 36 CFR 60.4, "Criteria for Evaluation"
8. 36 CFR 63, "Determinations of Eligibility for Inclusion in the National Register of Historic Places"
9. 36 CFR 800, "Protection of Historic Properties"

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ENVIRONMENTAL CHARACTERISTICS TEMPLATES

WATER USE

Hydrologic Impacts

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SITE CHARACTERISTIC: ENVIRONMENTAL /WATER USE / Hydrologic Impacts

DESCRIPTION: The feasibility analysis for hydrologic impacts can include potential impacts to both surface water and groundwater. Evaluation of potential surface water and groundwater impacts during plant construction and operation includes physical, thermal, radiological, and chemical impacts. Radiological impacts are evaluated in the Radiological Pathways template. Thermal impacts on surface water quality are discussed in the Aquatic Ecology template. Therefore, this template will focus on the chemical and physical water quality impacts.

IMPORTANCE: Impacts to water quality can generally be mitigated and is not often considered a “fatal flaw” (as far as site suitability is concerned); however, these mitigation plans can become costly. Adequate design alternatives can be developed to meet applicable Federal Water Pollution Control Act (FWPCA) requirements, National Pollution Discharge Elimination System (NPDES) permit requirements, and the NRC's regulations implementing the National Environmental Policy Act (NEPA). Depending on the plant location, additional state and local water quality standards may apply. Anticipation and management of water quality impacts is important to determine design alternatives, acquire the appropriate permits, and mitigate potential environmental impacts.

RISK: Failure by the applicant to certify to the NRC that all discharges from the facility will comply with applicable effluent limitations and other water pollution control requirements will prohibit NRC issuance of the construction permit, early site permit, or combined license, unless the requirement is waived by the State or the State fails to act within a reasonable period of time.

- EVALUATION:**
- Acceptable Site**
 - Challenged Site Requiring Further Evaluation**
 - Site Not Suitable**

DISCUSSION: **Site Type** - The type of site being evaluated (i.e., a “Greenfield,” “Brownfield “or “existing nuclear power plant” site) can have a significant impact on the analysis of hydrologic impacts, including surface water and groundwater quality. Potential sites located in “greenfields” may require more investigation to characterize water quality while existing power plants and Brownfield sites may possess extensive data. The intensity of each assessment will vary depending upon the quantity and quality of readily available data from existing plant sources and publicly available sources.

Evaluation Criteria - An Acceptable Site for the feasibility study is one that does not present surface water or groundwater quality

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hazards which may impede the issuance of necessary permits and licenses.

A Challenged Site (Requiring Further Evaluation) is one in which surface water or groundwater quality issues are identified and engineering design alternatives or mitigation measures may be necessary to meet water quality standards.

A Site Not Suitable evaluation occurs when the required mitigation measures are not reasonable, such as when a site is located in an area classified as a Class I groundwater aquifer.

Surface Water Controls

If plant design requires the discharge of thermal and chemical effluents, those effluents to navigable streams are governed by the 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. Other state and local regulations may also apply. Section 401(a)(1) of the FWPCA states, 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. Guidance states that this State certification is necessary unless the requirement is waived by the State or the State fails to act within a reasonable length of time.

A 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. Water quality impacts from dredging, scouring, siltation from construction disturbances, thermal discharges, or any other physical alteration may need to be managed to comply with the NPDES permit.

Where station construction or operation has the potential to physically or chemically degrade water quality to the possible detriment of other users, more detailed analyses and evaluation of water quality may be necessary.

Groundwater Classification

The EPA issued its Groundwater Protection Strategy in August 1984 and provided Guidance for Groundwater Classification in December 1986 (EPA, 1986) under its responsibilities as outlined in the SDWA. The Strategy established three general classes of groundwater representing a hierarchy of groundwater resource values to society as follows:

- Class I - Special groundwater

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- Class II - Groundwater currently and potentially a source of drinking water
- Class III - Groundwater not a source of drinking water.

Class I groundwater aquifers are highly vulnerable to contamination and are (1) irreplaceable sources of drinking water and/or (2) ecologically vital. Many states have adopted their own system based on the EPA strategy and have mapped the locations of groundwater classes. Groundwaters classified as Class I by state or federal agencies should be avoided.

Within a 2-mile (3.2-km) radius of the potential site, develop a utility function based on the percentage of Class II and Class III groundwaters. If these groundwaters have not been designated, utilize the procedures and data outlined in EPA guidance to evaluate the groundwaters within 2 miles (3.2 km) of the site. The EPA guidance (EPA, 1987) utilizes a numerical ranking system called DRASTIC, using readily available information on the following seven hydrogeologic characteristics:

- D - Depth to the water table
- R - Net Recharge
- A - Aquifer media
- S - Soil media
- T - Topography
- I - Impact of the vadose zone
- C - Hydraulic conductivity of the subject groundwater flow system

DRASTIC provides a standardized technical basis for evaluating the relative vulnerability of shallow aquifers to groundwater pollution. The higher an area scores on the index, the more susceptible to groundwater contamination. The numerical value obtained is related to two broad climatic regions in the country, based on whether the annual evapotranspiration exceeds mean annual precipitation. While it is always important to manage any potential releases of groundwater pollutants, sites with higher scores based on the DRASTIC evaluation may require additional mitigation.

Protection of Potable Water Supplies

The Safe Drinking Water Act Amendments of 1996 redefined "Public Water System" in SDWA Section 1401(4) as amended by 1996 SDWA Amendments (63 FR 41939, August 5, 1998). A public water system was previously defined to include only piped water systems (if such system has at least 15 service connections

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or regularly serves at least 25 individuals). The definition has now been broadened to include systems providing water for human consumption that deliver this water by constructed conveyances, such as irrigation canals.

Siting criteria relating to distance from public water systems appear to be more state-specific. The State may require the applicant to provide information pertaining to public water supply wells, which may be disturbed during construction or plant operation. Public water supply wells may be federally- or state-regulated.

The National Primary Drinking Water Regulations, Radionuclides; Final Rule (EPA) 65 FR 76707 of December 7, 2000, finalizes maximum contaminant level goals, maximum contaminant levels, and monitoring, reporting, and public notification requirements for radionuclides. This Rule is only applicable to community water systems. The Final Rule includes requirements for uranium, which is not currently regulated, and revisions to monitoring requirements for combined radium-226 and radium-228, gross alpha particle radioactivity, and beta particle and photon radioactivity. [EPA, SDWA] Site-specific groundwater monitoring would be conducted prior to plant construction.

Groundwater impacts under operating and accident conditions with respect to present and future users should be anticipated, by evaluating hydrologic parameters such as dispersion and dilution capabilities, potential groundwater contaminant pathways, general hydrologic complexity, location relative to water supply aquifers, aquifer classification by DRASTIC, etc. This evaluation may warrant more reliable investigation to assess the potential reactor impacts on groundwater. 10 CFR Part 100 states that site environmental parameters, which include hydrological characteristics, be characterized and used in or compared to those used in the plant Probabilistic Risk Assessment (PRA) and environmental analysis.

Risk - Failure to meet the NPDES permit requirements can result in fines, temporary shutdown of activities, construction delays, and could result in non-issuance of permit renewals. Potentially costly engineering design alternatives may be necessary for sites with complex hydrologic conditions or located in hydrologically sensitive areas.

Risk Mitigation - Engineering controls and design alternatives may need to be implemented to meet FWPCA requirements for thermal and chemical effluents and manage potential surface water and groundwater quality impacts. These mitigation measures should be anticipated and managed to the degree possible to control costs.

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REFERENCES:

1. 10 CFR Part 20, "Standards for Protection Against Radiation"
2. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."
3. 10 CFR Part 100, "Reactor Site Criteria."
4. U.S. Nuclear Regulatory Commission, "Design Basis Floods for Nuclear Power Plants," Regulatory Guide 1.59, Revision 2, August 1977.1
5. U.S. Nuclear Regulatory Commission, "Ultimate Heat Sink for Nuclear Power Plants," Regulatory Guide 1.27, Revision 2, January 1976.
6. U.S. Nuclear Regulatory Commission, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, Regulatory Guide 1.70, Revision 3, November 1978.
7. U.S. Nuclear Regulatory Commission "General Site Suitability for Nuclear Power Stations," Regulatory Guide 4.7, Revision 2, April 1998.
8. Entergy Nuclear, "Site Selection Criteria Guidelines for an Early Site Permit."

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SOCIOLOGICAL IMPACT CHARACTERISTICS TEMPLATES

Public Acceptance

Aesthetics

Environmental Justice Considerations

Socioeconomic Factors

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SOCIOLOGICAL IMPACT CHARACTERISTICS TEMPLATES

Public Acceptance

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FEASIBILITY PARAMETER: SOCIOLOGICAL IMPACTS / Public Acceptance

PARAMETER DESCRIPTION: Along with evaluating the physical characteristics that determine the suitability of a potential candidate site for industrial use, it is necessary to identify and evaluate potential public concerns of the communities surrounding the proposed plant site. Concerns that could be a factor include public resistance to the use of nuclear power, fear that an environmental resource or culturally sensitive area would be unduly compromised, the potential disproportionate impact to minority and/or low income populations, or preference to economic growth opportunities based on occupations, such as tourism, and not those related to industry or power generation.

PARAMETER IMPORTANCE: For initial feasibility study purposes, it is important to identify and eliminate sites where the potential exists for extensive public resistance to the idea of locating a plant in the vicinity. As the process moves towards submittal of NRC permit applications, the identification of potential community partners or stakeholders and attaining their acceptance and involvement becomes a key component to successfully locating a plant at a proposed site. As described in RG 4.2 and NUREG-1555 ESRP 9.3, there is a discussion of a "proposed" site compared to "alternative" sites. In this discussion, the site-selection methodologies are identified and the topic of public concerns is an aspect of the evaluated criteria. Therefore, for any site considered for licensing, it is important to characterize and document public acceptance or concerns since it will be need to be included in the licensing application and has the potential to excessively delay the licensing process.

PARAMETER RISK: During the feasibility study, if the extent of public concern of the idea of locating a plant is extensive and not recognized in the beginning of the process, then time and resources may be needlessly expended should the site be later dismissed. Also, once applications are submitted to the NRC, staff will evaluate the characterization of public acceptance at the proposed site along with the other parameters of site-selection. If the Environmental Review 9.3 discussion submitted by the applicant is not found to be sufficient, the NRC may request additional field work and analysis to be provided. Also, if excessive public concerns are identified, there is a risk that any license applications submitted would be contended, thus incurring increased cost and time.

- EVALUATION:**
- Acceptable Site**
 - Challenged Site Requiring Further Evaluation**
 - Site Not Suitable**

DISCUSSION: According to RG 4.7, at the initial stage of the feasibility study, investigations would be limited to reconnaissance-type research to ascertain if a history of opposition exists, or if the public accepts the idea of siting industrial facilities in an area. Data gathering

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would not rely on face-to-face interviews with public representatives. Instead, the focus of data gathering would begin with identifying any sensitivity to land use, environmental justice, or cultural practices that may be impacted by the construction or operation of the plant (see Land use, Environmental Justice, and the Ecology templates). The next step is gathering published planning documents from various agencies and organizations to determine the type of economic development being promoted in the area. Finally, research the any available news accounts detailing the political atmosphere of siting industry and/or power plants in an area, and whether a strong “culture” of public resistance or history of intervention exists.

Site Type – If a proposed site is associated with an existing nuclear power plant location, than public acceptance may not pose a problem because of a positive relationship between the current plant operator and the public at large. The opposite may also be true, where an existing negative relationship may act as interference to adding additional nuclear structures to the site. If a legacy of nuclear or a history of hazardous material already exists with a vacated “Brownfield” site, introducing the idea of siting a nuclear plant may be perceived as a viable reuse. Examining the history of public perception associated with the “Brownfield” site would provide guidance regarding the potential for public acceptance. A “Greenfield” site where no history of public acceptance exists would be the most difficult to characterize and data would need to be acquired as previously described.

Evaluation criteria- At the initial stage this feasibility study, acceptance or elimination of a potential proposed site based on public acceptability is a somewhat subjective decision process. Gauging the extent of potential public concern and deciding on levels of acceptability has no set measurement criteria. Suggested guidelines might include the following:

- An Acceptable Site designation occurs when no public concerns are identified and public acceptance would seem a matter of course (i.e. a proposed site associated with an established nuclear power plant where the operator has a positive relationship with the community.)
- A Challenged Site Requiring Further Evaluation designation occurs when historically, public acceptance of potential industrial sites in an area has garnered both positive and negative support, but opposition has not become extensive or extreme in nature (i.e. both “Brownfield” and “Greenfield” sites could fall under this evaluation).
- A Site Not Suitable designation occurs when the feasibility study reveals that a potential industrial or nuclear

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proposed site has historically garnered an extreme amount of public concern and contention. If societal conditions have not changed since the last occurrence, it may be likely that the resistance to siting a new plant still exists. Also, this designation may occur when new concerns are identified and the “impacted” community or group is well organized and set against the proposed project.

It is important to note that since this parameter is somewhat subjective, it is anticipated that the definitions of the Evaluation Criteria may require refinement based upon local knowledge and business needs.

Risk – If a plant operator or proposed site applicant does not control the release of information to the public, adverse public perception is possible. Also, if excessive public concerns are identified, the licensing and public relation processes could be lengthy and expensive.

Risk Mitigation – When a “proposed” site has been selected, involving the public early and providing information detailing the benefits of the project will increase the probability that the public will accept a potential plant being sited in or near their community.

REFERENCES:

1. U.S. Nuclear Regulatory Commission, Regulatory Guide 4.2, “General Site Suitability Criteria for Nuclear Power Stations,” Section 9.2.1 “Selection of Candidate Areas”
2. U.S. Nuclear Regulatory Commission, Regulatory Guide 4.7, “General Site Suitability Criteria for Nuclear Power Stations,” “Introduction”
3. U.S. Nuclear Regulatory Commission, NUREG-1555 ESRP 9.3, “Alternative Sites”

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SOCIOLOGICAL IMPACT CHARACTERISTICS TEMPLATES

Aesthetics

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SITE CHARACTERISTIC: **SOCIOLOGICAL IMPACTS / Aesthetics**

DESCRIPTION: In the process of preparing a site feasibility study, the potential for adverse aesthetic impacts in the vicinity or in the region should be considered. Aesthetic impacts would most likely take place during the construction and/or operation phase of the project. During the construction phase, impacts could include construction noise, odors, dust, etc., at the plant and along transmission and access corridors. During the operation phase, the aesthetic perception created by the plant layout, landscaping, architectural features, and operational activities could be of aesthetic concern.

IMPORTANCE: According to RG 4.7, “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” (see the Land Use Template discussion). NUREG-1555 states “The depth and extent of the input to the EIS should be governed by aesthetic and land-use considerations that could be affected by station layout and by the nature and magnitude of the expected impacts.” Aesthetics issues caused by location of industry and power facilities in an area can produce negative socioeconomic impacts for both the surrounding populations and the economic foundation of a community.

RISK: The NRC staff will evaluate the aesthetic mitigation plans to determine if the significance of potential impacts to the surrounding area and the aesthetic design features integrated into the project are reasonable and affective. If the mitigation plans are found to not be sufficient, then the NRC may request new design features and/or mitigation strategies that would reduce the impact. This process could become expensive and possibly cause delays.

- EVALUATION:** **Acceptable Site**
 Challenged Site Requiring Further Evaluation
 Site Not Suitable

DISCUSSION: Knowledge of the selected plant technology and design features are key elements in understanding potential aesthetic impacts a candidate plant may have on the surrounding area. As a site feasibility study is undertaken, understanding the potential for adverse aesthetic impacts caused by the design of a plant and the location of a plant should be taken into consideration during the identification of any area land use issues. Socioeconomic issues such as environmental justice are also a parameter that should be contemplated.

Site Type – Should an existing nuclear power plant be associated with siting potential nuclear structures, than the negative impacts caused by design features may not be as great a concern.

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Impacts from construction could still be an issue, but these tend to be temporary in nature. Regarding analysis of feasible sites associated with “brownfield” locations, aesthetics mitigation may have been previously completed and evaluated. Whereas, an aesthetics analysis will not have been completed for a “Greenfield” site and no mitigation plans will have been developed.

Evaluation Criteria - An Acceptable site evaluation occurs when no aesthetic impacts are identified near the site or related facilities such as station access roads and railroads.

A Challenged Site (Requiring Further Evaluation) occurs when aesthetic impacts are identified.

A Site Not Suitable evaluation cannot be achieved at this stage because it is dependent upon the failure of mitigation options.

Risk - There is no risk of application rejection from the NRC; however, this issue may require mitigation if any impacts are identified. There is a possibility the mitigation efforts can be unreasonably expensive to pursue.

Risk Mitigation - “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, and the integration of structures with the environment can mitigate adverse visual impacts” (Regulatory Guide 4.7).

REFERENCES:

1. U.S. Nuclear Regulatory Commission, Regulatory Guide 4.7 “General Site Suitability Criteria for Nuclear Power Stations”
2. U.S. Nuclear Regulatory Commission, NUREG-1555, SRP 3.1 “External Appearance and Plant Layout”

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SOCIOLOGICAL IMPACT CHARACTERISTICS TEMPLATES

Environmental Justice Considerations

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SITE CHARACTERISTIC: **SOCIOLOGICAL IMPACTS / Environmental Justice Considerations**

DESCRIPTION: The potential for environmental justice issues at a candidate site is primarily based upon the identification of disproportionate impacts to low income and minority populations as defined by LIC-203, Appendix D. Often, these issues are difficult to mitigate, and may cause complications for any site being licensed by the NRC. This template will focus on identifying low income and minority populations using the NRC’s guidance. The proximity of identified low income and minority populations to the site, transmission and transportation routes to the site will be used as an indicator for potential environmental justice considerations.

IMPORTANCE: RG 4.7 states “the NRC is 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. 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.”

RISK: The NRC staff will evaluate the environmental justice considerations to identify the possibility of an environmental justice issue. If low income or minority populations are identified, the NRC will evaluate the impacts on these populations that may be disproportionate and significant. Any significant or disproportionate impacts may prompt the NRC to include regulatory actions that involve significant site modification or mitigation.

The identification of a disproportionately high and adverse human health or environmental effect on a minority or low-income population does not preclude a proposed agency action from going forward, nor does it necessarily compel a conclusion that a proposed action is environmentally unsatisfactory. Rather, the identification of such an effect should heighten agency attention to alternatives (including alternative sites), mitigation strategies, monitoring needs, and preferences expressed by the affected community or population.

The NRC staff also considers the suitability of a site located near distinctive communities. They require a demonstration that the construction and operation of the nuclear station, including transmission and transportation corridors, will not adversely affect the distinctive character of the community. However, identifying distinctive communities require more detailed analysis that is not appropriate as part of this feasibility study. It is important to note; however, that while a site may be acceptable at this level,

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research into distinctive communities will need to be addressed at the next stage.

EVALUATION:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION:

Low income and minority populations located within the region around the plant should be identified. The proximity of identified low income and minority populations to the site, transmission and transportation routes to the site will be used as an indicator for potential environmental justice considerations.

Site Type - The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield “, or “existing nuclear power plant” site. The evaluation should identify the unique applicability of site type-related differences, if any, for the treatment of this issue. In addition, the evaluation should take into consideration existing data and analyses that might be available, for example, in the case of an existing nuclear site or, perhaps, a “Brownfield site.” In these cases the environmental justice analysis may have been previously completed and evaluated. Whereas, an environmental justice analysis will not have been completed for a Greenfield site.

It is important to note that while this parameter has been previously evaluated, updated information will still need to be obtained to ensure that the situation has not changed since the last review.

Evaluation Criteria - An Acceptable site evaluation occurs when no low income or minority populations are identified near the site or along transmission or transportation routes.

A Challenged Site (Requiring Further Evaluation) occurs when low income and minority populations are identified near the site or along transmission and transportation routes.

A Site Not Suitable evaluation cannot be achieved at this stage because it is dependent upon the failure of mitigation options. Environmental justice mitigation requires detailed analysis and corporate decision making not included in the feasibility process.

Environmental Justice Analysis

To identify low income and minority populations, a GIS based analysis should be performed. Environmental Systems Research Institute (ESRI) data can be used for the initial screening.

According to LIC-203, “A ‘minority population’ is considered to be present if: 1) the minority population in the census block group or environmental impact site exceeds 50 percent, or 2) the minority population percentage of the environmental impact area is

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significantly greater (typically at least 20 percentage points) than the minority population percentage in the geographic area chosen for the comparative analysis, for example, the county or State.

A 'low-income population' is considered to be present if: 1) the low-income population in the census block group or the environmental impact area exceeds 50 percent, or 2) the percentage of households below the poverty level in an environmental impact area is significantly greater (typically at least 20 percentage points) than the low-income population percentage in the geographic area chosen for the comparative analysis."

Using these thresholds, identify the U.S. Census blocks and block groups that exceed the criteria as listed above. The result is the identification of the regional low income and minority populations.

Risk - There is no risk of application rejection from the NRC; however, this issue is easily contested legally which could lead to extensive site alteration and mitigative efforts that could cause the site to be unreasonably expensive to pursue.

Risk Mitigation - By performing an extensive environmental justice review, the anticipated impacts to the identified low income and minority population can be evaluated. If it can be argued that the impacts are not disproportionate, then the risk of mitigation and site alteration is reduced.

REFERENCES:

1. Executive Order 12898 (59 FR 7629), "Federal Actions To Address Environmental Justice In Minority Populations And Low-Income Populations"
2. Council on Environmental Quality "Environmental Justice" Dec 10, 1997
3. U.S. Nuclear Regulatory Commission, Regulatory Guide 4.7 "General Site Suitability Criteria for Nuclear Power Stations"
4. NRR Office Letter No. 906 Rev 1 "Procedural Guidance for Preparing Environmental Assessment Considering Environmental Issues"
5. NRR Office Instruction No. LIC-203, Rev 1 "Procedural Guidance for Preparing Environmental Assessments Considering Environmental Issues"
6. U.S. Nuclear Regulatory Commission, NUREG-1555, SRP 2.5.4 "Environmental Justice"

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SOCIOLOGICAL IMPACT CHARACTERISTICS TEMPLATES

Socioeconomic Effects

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SITE CHARACTERISTIC: **SOCIOLOGICAL IMPACTS / Socioeconomic Effects**

DESCRIPTION: The potential for impacting communities in the region can be caused by a variety of factors during the construction and operation phases of a nuclear site. The impacts on regional communities, transportation facilities, and community services should all be reviewed. The community infrastructure and services that are impacted may require mitigation before a regulatory action can be completed. In many cases, the mitigative efforts can be achieved through coordination between the applicant and the local community and government agencies; however, some of these efforts could prove too expensive. This template will focus on using the NRC’s guidance to evaluate whether a site has issues that will reduce the likelihood of producing a successful application.

IMPORTANCE: The NRC will evaluate the impact of construction and operation on the local labor supply, transportation facilities, taxes, schools, police resources, fire fighting resources, potable water, wastewater, historical characteristics, distinguished cultural characteristics, and any other local infrastructure that may be impacted. If any significant impacts are found, the NRC will look for coordination between the applicant and the impacted communities for the resolution of these issues.

RISK: The NRC will evaluate the suitability of a site including 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.

- EVALUATION:** **Acceptable Site**
 Challenged Site Requiring Further Evaluation
 Site Not Suitable

DISCUSSION: The siting, construction, and operation of a nuclear power station may have significant impacts on the socioeconomic structure of a community and may place stress on the local labor supply, transportation facilities, and community services in general. There are often changes in the tax base and in community expenditures due to the additional population (e.g., construction and operational workforces). In addition, the “boom and bust” cycle of population, and its associated impacts, often caused by the construction workforce is carefully reviewed by the NRC.

Site Type - The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield “, or “existing nuclear power plant” site. The evaluation should identify the unique applicability of site type-related differences, if any, for the treatment of this issue. In addition, the evaluation should take into

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consideration existing data that might be available, for example, in the case of an existing nuclear site or, perhaps, a Brownfield site. In these cases the socioeconomic analysis may have been previously completed and evaluated. It is important to note that while this parameter has been previously evaluated, updated information will still need to be obtained to ensure that the situation has not changed since the last review.

Evaluation Criteria - An Acceptable Site for the feasibility study is one that does not exceed the capacity or adequacy of any of the existing or currently-planned infrastructure or community services.

A Challenged Site (Requiring Further Evaluation) is one in which the capacity of existing or currently-planned infrastructure or community services is exceeded but can be reasonably mitigated.

A Site Not Suitable evaluation occurs when the capacity of existing or planned infrastructure and community services are exceeded and it is not reasonable to mitigate impacts.

Local Labor Supply

The effects on the regional labor supply due to plant construction and operation could cause a regional labor shortage and affect the regional communities. This can be predicted using local unemployment reports. If the unemployment rate is high for the region, the addition of new jobs is favorable to the communities in the region. If there is a labor shortage the impacts may require mitigation. This information can be obtained from the Bureau of Labor Statistics and can be obtained at a county and state level.

Transportation Facilities

The current transportation system should be evaluated to determine if the addition of workforce vehicles and construction and operational deliveries would cause an impact. To be conservative, an estimation of one vehicle per person would be sufficient for this level of review. If the current transportation system cannot handle the number of cars and trucks expected to be present during peak construction, mitigation efforts may be required. To evaluate this issue, the Highway Capacity Manual, published by the Transportation Research Board, provides information on the Quality of Service (QOS) and capacities of highways within the United States. With this information, calculate the current capacity of roads leading to the site. Estimate the number of vehicles and deliveries required for the construction and operation of the planned plant and identify if the road exceeds its current capacities. If the traffic is expected to exceed the capacity of the current transportation system, mitigation may be warranted.

Community Services

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If community services such as police, fire fighting, schools, potable water, and waste water will be beyond capacity during construction or operation, mitigation may be warranted. To evaluate this category, gather information related to local social services (hospitals, police, firefighters, schools, etc.). Next, compare the police to citizen, firefighter to citizen, doctor to citizen, and student to teacher ratios, to state and national averages. Then, compare the current water and wastewater capacities to the anticipated impacts due to construction and operational workers water needs, as well as any plant operational water needs. If any of these comparisons indicate that the additional population and service requirements cause the current capacities to be exceeded, mitigation may be warranted.

Fiscal assessment

If a community is expected to be impacted and their infrastructure needs to be improved, the timing and amount of taxes used to make improvements needs to be evaluated. If any shortfalls are expected, a mitigation plan will need to be evaluated. The ownership of this mitigation will most likely be a collaborative effort between the applicant and the city or local government agency being impacted. This assessment is based on expected taxes paid by the plant, immigrating workers, and mitigative efforts. For this study, evaluate current tax information and see if local governments are experiencing budget shortfalls. If budget shortfalls exist then the community may be less able to upgrade any social services or transportation networks without financial assistance.

Risk - In cases where the local community resources are stressed (e.g., lack of available funding to upgrade services and resources), mitigative efforts may be required. In some instances, these efforts could become expensive.

Risk Mitigation - A full evaluation of the impacts on the communities will have to be evaluated. Mitigative efforts will have to be discussed with local authorities and thoroughly planned. Funding problems for these mitigative efforts through taxes will have to be resolved.

REFERENCES:

1. U.S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations"
2. U.S. Nuclear Regulatory Commission, NUREG-1555, SRP 2.5.2, "Community Characteristics"

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OTHER SITE CHARACTERISTICS TEMPLATES

Land Availability

Site Constructability Factors

Potential for Brownfield Contamination Issues

**Features that Could Affect Development of Security Measures and Adequate
Security Plans**

Sample Template

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OTHER SITE CHARACTERISTICS TEMPLATES

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SITE CHARACTERISTIC: OTHER / Land Availability

DESCRIPTION: This parameter includes the availability of the necessary land area and buffer zones for the plant, including switchyard and transmission facilities, and the cost of acquiring of those lands. The necessary land area and buffer zones are described below.

For Brownfield sites, performing due diligence and any attendant regulatory-mandated cleanup activities should also be considered and identified for evaluation using the template for "Potential for Site Decontamination Issues."

IMPORTANCE: Federal regulations including 10 CFR 100.21 and 10 CFR 100.3 require every site to have an exclusion area and defines "*Exclusion Area (EA)*" as that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area.

The specific requirements relative to the EA are given in 10 CFR 50.34(a)(1)(ii)(D) as follows:

- (1) An individual located at any point on the boundary of the exclusion area for any 2 hour period following the onset of the postulated fission product release, would not receive a radiation dose in excess of 25 rem total effective dose equivalent (TEDE).
- (2) An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a radiation dose in excess of 25 rem total effective dose equivalent (TEDE).

A site should include enough contiguous land to meet the requirements summarized above. Additionally, the cost to obtain the property and/or land rights may have a large effect on overall plant costs.

RISK: The required EA size will be based on radiological criteria, as described in the siting template for Atmospheric Dispersion. The NRC staff will review the sizing of the EA and the licensee control over that area to ensure they meet the criteria in 10 CFR 50.34, 10 CFR 100.21 and 10 CFR 100.3.

If it is questionable that there is sufficient land available at a cost that is acceptable, then it might not be possible to ensure that the EA size and control requirements will be met. Failure to meet EA size and control requirements could cause the site to be deemed unacceptable. The licensee should have confidence that they will be able to provide the requisite level of control within the EAB.

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EVALUATION:

- Acceptable Site**
- Challenged Site Requiring Further Evaluation**
- Site Not Suitable**

DISCUSSION:

Discuss the basis for the evaluation result, including the type of site evaluated, the information gathered, the evaluations examined or performed and the evaluation criteria. Where risks have been identified, discuss risk mitigation factors.

Site Type - Identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield” or “existing nuclear power plant” site. The types of evaluations to be performed will depend on the site type. For an existing nuclear power plant site, land availability/cost might not be an issue. For a Brownfield site, the potential for regulatory-mandated cleanup activities should be evaluated, using the template for “Potential for Site Decontamination Issues.” For a Greenfield site, discuss the potential for compensatory environmental or land use reparations, which might be required to make up for the land lost to the plant.

Evaluation Criteria - A site may be evaluated as an “acceptable site” if it is determined that there is sufficient land in an appropriate configuration available at an acceptable cost to allow the plant facilities to be sited in such a way as to satisfy the requirements of 10 CFR 100 and 10 CFR 50.34 with respect to EAB and control.

A site may be evaluated as a “challenged site” if the site might be found acceptable upon further examination of specific issues. Such issues might include permit issues, ownership boundary issues, compensation issues, site configuration issues (shape, affecting distance to nearest EAB), transmission ROW issues, etc. A site also may be evaluated as a “challenged site” if the costs of relocating existing site structures or facilities has yet to be calculated.

A site may be evaluated as “not suitable” if it is estimated that the nearest EAB distance will not meet the requirements of 10 CFR 100 and 10 CFR 50.34 or if it has been determined that it would not be possible to demonstrate control over all of the activities within the EAB.

Land Availability Analysis

The availability of obtained ownership or control over enough land to encompass the exclusion area zone should be determined early in the site evaluation process. The licensee should have confidence that they will be able to provide the requisite level of control over the Exclusion Area.

The Exclusion area is that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities

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including exclusion or removal of personnel and property from the area. Specifically, applicants must ensure that there is adequate land area at the existing site so that an exclusion area can be established for the new unit(s) which satisfies the requirements of 10 CFR 100.

This area may be traversed by a highway, railroad, or waterway, provided these are not so close to the facility as to interfere with normal operations of the facility and provided 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. Residence within the exclusion area shall normally be prohibited. In any event, residents shall be subject to ready removal in case of necessity. Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result.

The evaluation should determine existing residence within the planned exclusion area. Residence should normally be prohibited, or it should be determined that residents would be subject to ready removal in case of necessity. If it is determined that there will be activities in the site area that are unrelated to operation of the reactor a site may be judged as “challenged,” and additional evaluations might be necessary to determine if appropriate limitations can be placed on the activities, such that that no significant hazards to the public health and safety will result.

In determining land availability and cost acceptability the evaluator should review land ownership records, aerial/satellite imagery, maps, and population data.

Risk - There is a risk of application rejection from the NRC if other sites are deemed to be superior to this site. If site acquisition involves many displacements, or if site preparation involves major environmental disruption, then the site could be rejected by the NRC in favor of alternative sites or contested legally which could lead to extensive site alteration and mitigative efforts that could cause the site to be unreasonably expensive to pursue.

Risk Mitigation - For sites where the licensee may not currently have such control over the required land mass a review of ownership should be conducted. Where land ownership records are available they should be used. Alternatively, satellite photo images publically available can be used for a more qualitative assessment, e.g. is it farmland, approximately how many people live on the land, is there likely to be multiple owners of the land, etc. As much data that can be obtained about the ownership and likelihood of being able to acquire control over the land will reduce the risk of this issue.

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REFERENCES:

1. 10 CFR 100.21, "Non-Seismic Siting Criteria"
2. 10 CFR 100.3, "Definitions"

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OTHER SITE CHARACTERISTICS TEMPLATES

Site Constructability Factors

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SITE CHARACTERISTIC: OTHER / Site Constructability Factors

DESCRIPTION: The feasibility of constructing a nuclear plant at a particular site is dependent on two main issues 1) the ability to deliver construction equipment and major plant components to the reactor location, and 2) the ability to deliver plant outputs desired by the customer: electricity to the transmission line grid, and/or process heat and/or steam to the required location. Each of these parameters need to be met in a manner that is not cost prohibitive. There are numerous other factors that have major impacts and/or risks to construction costs including the availability of an adequate and skilled work force, difficulty establishing a footprint for the reactor building, and availability of construction materials.

IMPORTANCE: Overall construction costs can vary greatly from site to site depending on the existing infrastructure surrounding the site. The plant must obviously connect to the utilities' electrical grid and there may be large obstacles to providing that connection for Brownfield and Greenfield sites. Factors include the relative difference in the distance to the nearest load center, whether it is even feasible to procure the land for a right of way, and whether it is likely to receive approval from FERC for a transmission line as proposed.

Large reactor components must be delivered either by rail or by barge. If the site is accessible by barge that is a very good method of transporting the heavy loads involved. If not, then a connection to an in-service railroad line must be provided. Similar to the transmission line, if the distance is too great, the land cannot be procured, or state approvals are unlikely, then it could be cost prohibitive to install a spur to the site.

For locations where process heat and/or steam is a desired output the feasibility of accomplishing this in a cost effective manner must be analyzed. There are logistical limitations to providing process heat and/or steam especially if the customer facilities cover large areas of land. Information provided by the end user should be used to compare against design features of the reactor type and the site location relative to the end use location.

RISK: The major risk factors include the ability to install transmission lines, if there are no existing lines, the ability to transport heavy loads associated with construction equipment and plant components to the site, and the ability to deliver sufficient process heat and/or steam to the desired location.

- EVALUATION:**
- Acceptable Site**
 - Challenged Site Requiring Further Evaluation**
 - Site Not Suitable**

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DISCUSSION:

Discuss the basis for the evaluation result, including the type of site evaluated, the information gathered, the evaluations examined or performed and the evaluation criteria. Where risks have been identified, discuss risk mitigation factors.

Site Type - The evaluation should recognize the type of site being evaluated, i.e., a “Greenfield,” “Brownfield” or “existing nuclear power plant” site. For an existing nuclear power plant site this is probably not even an issue unless a new transmission line corridor is required. For a Brownfield or Greenfield site this issue becomes increasing more important. For example there must be a means to get construction equipment and the large reactor components to the reactor location. With no infrastructure available a new railroad spur, new roads, etc may be required to support construction.

Evaluation Criteria - A site may be evaluated as an “acceptable site” if it is determined that there is sufficient access to the transmission line grid, there is a means to get major plant equipment to the reactor location and it is feasible to get process heat and/or steam to the required location, all in a cost effective manner.

A site may be evaluated as a “challenged site” if the site might be found acceptable upon further examination of specific issues. Such issues might include permit issues, ownership boundary issues, compensation issues, transmission ROW issues, etc. For sites requiring process heat and/or steam the evaluator must look into the distance and traverse path for getting the product to the desired location at the required design conditions. A site also may be evaluated as a “challenged site” if the costs of installing a railroad spur or new transmission lines have yet to be calculated.

A site may be evaluated as “not suitable” if it is determined not feasible to deliver either construction equipment or major plant components (e.g., reactor vessel) or it is judged cost-prohibitive to do so. A site may be evaluated as “not suitable” if it is determined not feasible to provide transmission access or it is judged cost-prohibitive to do so. A site may be evaluated as “not suitable” if it is determined not feasible to provide process heat and/or steam at the required design conditions or it is judged cost-prohibitive to do so.

All of the following issues are related to plant construction costs. Only three have been identified as making a site unacceptable on their own merits. However, the construction challenges should be looked at from the whole and include other considerations such as availability of a labor pool, terrain and how much earth and rock need to be moved, availability of concrete or the ability to make concrete on site, etc. The evaluator is responsible for identifying the key construction issues applicable to the site and to make an overall determination of acceptability.

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Transmission Lines – The evaluator should determine whether existing transmission line capability is available to deliver power from the new reactor or whether a new transmission line is required. For an existing nuclear site this evaluation may only require an assessment to determine if there is sufficient capacity in the existing transmission lines to accommodate the new reactor. Alternatively, investigate the feasibility of installing a new transmission line within the existing right-of-way. For Brownfield and Greenfield sites the evaluator must review system grid drawings and determine available connection points. Then an assessment of potential locations for a right-of-way, obstacles to ownership of the property, and the likely regulatory issues that must be addressed is required.

Heavy Loads - For an existing nuclear site shipment of heavy loads to the site should not be a problem because they have done so in the past. For Brownfield and Greenfield sites the evaluator must determine whether there is an acceptable way to get the major plant components and construction equipment to the site. Barging if available is a good method for this. Rail shipments are also feasible as long as there is the feasibility of connecting to an in-service rail line at a reasonable cost. The evaluator should identify the local rail lines and determine the feasibility of installing a local spur, i.e., availability of the land, right-of-way access, and length of travel.

Process Heat - For locations where process heat and/or steam is a desired output the feasibility of accomplishing this in a cost effective manner must be analyzed. There are logistical limitations to providing process heat and/or steam especially if the customer facilities cover large areas of land. Information provided by the end user should be used to compare against design features of the reactor type and the site location relative to the end use location. The evaluator must consider the distance and traverse path to providing the desired product to the location at the required design conditions

Labor Force – The construction of a nuclear power plant is very labor-intensive. With the possibility of a wave of new nuclear plants being constructed simultaneously there is likely to be a shortage of skilled labor to complete the construction. Commuting distance proximity to a skilled labor pool may make one site favorable and another not favorable. The evaluator should make an assessment of the ability to retain a work force at the site during the construction period. Considerations include the ability of the community to support temporary workers. This item is further discussed in the Template on Socioeconomics.

Excavation – The amount of excavation and associated cost is likely to vary considerably from site to site. For an existing nuclear

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site, and probably for a Brownfield site, this should not be a significant factor unless the bedrock is relatively close to the surface. For a Greenfield site the evaluator should perform a high level review to determine the feasibility and potential costs associated with excavation. One consideration is the topography of the site and the amount of dirt that will require excavation in order to establish a footprint for the plant. For example, areas with slopes greater than 12% mean slope, or greater than 400 feet (123 m) relief within the minimum site area, would be considered unacceptable. The other consideration is the required depth of the reactor building versus the level at which bedrock exists. The evaluator should determine the approximate depth of the bedrock based on readily available geotechnical data of the region or other source of estimation and estimate the impacts of the existence of bedrock at the reactor building foundation.

Concrete Availability – Nuclear plant construction typically requires large quantities of concrete to be available. If the site is not located near a cement factory or rock quarry, so that concrete can be manufactured locally, it may make that site construction cost prohibitive.

Risk Mitigation - For each of the three risk parameters an evaluation needs to be conducted early-on in the process because either one could render the site to be considered unacceptable. Sites that may require a new transmission line corridor will require a review of ownership of land that would provide for the right-of-way. Where land ownership records are available they should be used. Alternatively, satellite photo images publically available can be used for a more qualitative assessment, e.g., is it farmland, approximately how many people live on the land, is there likely to be multiple owners of the land, etc. As much data that can be obtained about the ownership, and likelihood of being able to acquire control over the land will reduce the risk of this issue.

For sites that have no access to barge traffic a railroad spur may be required. The evaluator should look at the accessibility to an in-service railroad line and the feasibility of installing a spur to the site. Again, where land ownership records are available they should be used. Alternatively, satellite photo images publically available can be used for a more qualitative assessment, e.g., is it farmland, approximately how many people live on the land, is there likely to be multiple owners of the land, etc.

For sites requiring process heat and/or steam the distance that must be traversed may prohibit the site for use because the product cannot be delivered at the required design conditions. It is important to know precisely the design conditions required by the customer because there may be a design solution that can be considered.

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OTHER SITE CHARACTERISTIC TEMPLATES

Potential for Brownfield Contamination Issues

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SITE CHARACTERISTIC: OTHER / Potential for Brownfield Contamination Issues

DESCRIPTION: The potential for (residual) contamination at a candidate site (Brownfield or existing nuclear power plant (NPP) site) may involve radiological contamination or non-radiological contamination. The potential contamination could be in any form, including spills, settling ponds, buried solids, buried containers, gas containers or contaminated structures or equipment.

IMPORTANCE: The possibility of residual contamination (most likely non-radioactive) at a Brownfield site can complicate excavation and construction at the site and can greatly delay such activities while the contamination is adequately characterized and dispositioned. Similarly, new excavation at an existing NPP site might encounter some form of contamination (radioactive or non-radioactive), though less likely. Extensive regulations come into play for decontamination activities. Also, if contamination is discovered, it might not be possible simply to ignore it. Therefore, if the evaluating client already owns the site property, then cleanup might be mandated even if the site is not further developed.

RISK: The risks associated with potential contamination at existing NPP sites include the possibility that the discovery of contamination and its subsequent treatment could hinder ongoing nuclear plant operations.

Brownfield site contamination evaluation risks include the possibility that the initial assessment grossly underestimates the extent of the contamination or that subsequent satisfactory treatment (i.e., removal/disposal) of the contamination might prove to be physically impossible or prohibitively expensive. Another risk is that the removal process could result in additional contamination, further complicating the cleanup process and increasing the cost. Therefore, an accurate first assessment of the possibility of contamination is crucial.

- EVALUATION:**
- Acceptable Site**
 - Challenged Site (Requires Further Evaluation)**
 - Site Not Suitable**

DISCUSSION: The further development of existing NPP sites and the redevelopment of Brownfield sites are subject to a variety of federal, state, and local laws, regulations, policies, and guidelines, including those related to the identification of site contamination and site cleanup. Such sites also may be governed by the standard practices of other government, nongovernment, and private institutions.

The Resource Conservation and Recovery Act (RCRA), enacted in 1976, is the principal Federal law governing the disposal of solid waste and hazardous waste. The applicable laws, regulations,

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policies, and guidelines will vary by site, depending on the regulatory authority that manages the cleanup. Therefore, it is important to identify the appropriate regulatory agency(s), have them determine the site specific requirements and approvals/permits needed for site investigations, and work closely with the appropriate regulatory authority throughout the cleanup process. EPA also can be a valuable resource by providing regulatory and policy support to facilitate selection of technologies.

Several steps are involved in determining the potential for and extent of contamination of a site. These include: coordinating with the pertinent regulatory agencies, retaining the services of a consultant to carry out the site investigations, and conducting the necessary investigations. Procuring the services of a qualified consultant is an important step in determining the existence and extent of contamination, if any, on a Brownfield site.

Site Type - Existing nuclear power plant site or Brownfield site. The evaluator should identify the prior use of the site to aid in the identification of possible contaminants and the development of the appropriate evaluation techniques.

Evaluation Criteria -

Non-Radiological Contamination Potential

Acceptable Site: Metals or limited chemicals that make it a Brownfield with limited public risk.

Challenged Site (Requires Further Evaluation): RCRA closure site or site managed under state RCRA rules– Materials often are not defined as hazardous, but meet a more stringent state definition for metals or other chemicals. Alternately, the extent of contamination requires a Phase II Environmental Assessment for the purpose of providing sufficient information regarding the nature and extent of contamination to assist in making informed business decisions about the property.

Site Not Suitable: Characteristically Hazardous – Results in a potentially large risk of metals and/or chemicals.

Radiological Contamination Potential

Acceptable Site: No residual contamination or no possibility to cause a water pathway that will result in a radiological dose via the water pathway beyond regulatory limits.

Challenged Site (Requires Further Evaluation): The extent of contamination requires a Phase II Environmental Assessment for the purpose of providing sufficient information regarding the nature and extent of contamination to assist in making informed business decisions about the property.

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Site Not Suitable: The possibility exists that will result in a radiological dose via the water pathway beyond regulatory limits.

Fundamentally, any site that has a history of contamination should have no way to cause a water pathway radiological dose beyond regulatory limits. Since this is a Brownfield site there is a strong justification to use the industrial release scenario for this site versus a residential farmer scenario. For existing nuclear power plant sites there will be readily available data to support an assessment of cost due to the requirements in 10 CFR 50.75(g), "Reporting and Recordkeeping for Decommissioning Planning," and participation in the NEI Groundwater Protection Initiative Program.

The critical cost of a decommissioning project is the volume of soil that must be removed during final decommissioning. The single driver for this cost is the concentration that meets final release, defined by the NRC as 25 mrem to a member of the public. This is calculated with RESRAD, a DOE model that the NRC accepts as the standard calculation method. The water pathway associated with the residential farmer scenario will significantly reduce the concentrations that can be left behind at site release.

An industrial release can increase the remaining radiological concentrations by an order of magnitude or more for some isotopes. There are a number of pathways that can be analyzed in the model depending on the approved release scenario. For an industrial scenario, water and food pathways are eliminated and site exposure time is significantly reduced. This in turn has the effect of leaving a higher level of contamination in place when the site is released. It is identical to a-risk based Brownfield scenario which assumes that a site will be industrial or in some other way used to limit exposure pathways and duration.

Contamination Analysis

A Phase 1 Environmental due diligence assessment should be conducted. This assessment is the systematic determination of the potential for environmental conditions, issues, and liabilities at the Brownfield site. Since by nature, Brownfield sites are considered to be impacted in some degree by past uses and therefore the potential does exist for the presence of contamination, environmental due diligence is essential to successful Brownfield site transaction and redevelopment. These activities support two basic objectives:

Transactional: In order to provide assurance for lenders, investors and other stakeholders involved with the property transaction.

Legal: To meet liability protection and regulatory obligations under federal and state environmental laws, as applicable.

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A Phase I Environmental Assessment is the first step in evaluating the potential environmental issues with a Brownfield site. It generally involves a review of readily available information on the potential presence of contamination; the potential, existing or past contaminant releases; and the possible paths of exposure that would be of concern. Interviews with community members and others can also be conducted to determine past practices associated with a particular site. This initial effort could be combined with developmental data gathering, particularly in regard to the potential land use for the site. A Phase I Assessment can provide information to developers, municipal planners and the community early in the assessment process on potential environmental concerns which would be helpful in initial planning regarding land use and the viability of the property for redevelopment.

A component of the Phase 1 process is All Appropriate Inquiry (AAI). EPA defines All Appropriate Inquiry as the requirements for assessing the environmental conditions of a property prior to its acquisition. AAI is the Phase 1 process identified in the Brownfield Law and as such, EPA Brownfield Grantees are required to assess and characterize properties in accordance with All Appropriate Inquiry standards. Such inquiries must be conducted or updated within one year prior to the date of acquisition of a property. If all appropriate inquiries are conducted more than 180 days prior to the acquisition date, certain aspects of the inquiries must be updated.

The inquiries must be conducted by a Qualified Environmental Professional (QEP) which is defined as "someone who possesses sufficient specific education, training, and experience necessary to exercise professional judgment to develop opinions and conclusions regarding conditions indicative of releases or threatened releases of hazardous substances on, at, in, or to a property, sufficient to meet the objectives and performance factors of the rule". (ASTM International's E1527-00 standard, "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process" may be used to comply with the AAI requirements.)

The AAI generally includes:

- interviews with past and present owners, operators and occupants;
- reviews of historical sources of information;
- reviews of federal, state, tribal and local government records;
- visual inspections of the facility and adjoining properties;
- commonly known or reasonably ascertainable information;

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- degree of obviousness of the presence or likely presence of contamination at the property and the ability to detect the contamination.
- searches for environmental cleanup liens;
- assessments of any specialized knowledge or experience of the prospective landowner (or grantee);
- an assessment of the relationship of the purchase price to the fair market value of the property, if the property was not contaminated; and commonly known or reasonably ascertainable information.

More information on EPA's All Appropriate Inquiry rule can be found at <http://www.epa.gov/Brownfields/regneg.htm>.

Site Reconnaissance

A site reconnaissance supplements the Phase I Assessment by visually observing the site and its surrounding areas. This reconnaissance should expand the understanding of site conditions. Specific objectives of the reconnaissance include: documenting the physical features of the site (i.e. dimensions, buildings etc.) and the surrounding area; recording any differences from the information gathered in the Phase I; identifying any sources of hazardous substances and pathways that may be of concern; and, identifying any new features that may have an impact in the assessment and decision regarding the site. Preparation for the reconnaissance will include: reviewing all information garnered from the Phase I, arranging for site access, and identifying any health and safety concerns.

Risk - One potential risk is site rejection because the possibility exists to cause a water pathway that will result in a radiological dose to the water pathway beyond 4 mrem.

A second risk is that site contamination might be more extensive or pervasive than the initial feasibility assessment was able to determine. This can lead to unexpected delays and expense later in the site development phase.

If the evaluating client already owns the site, another risk is that the discovery of contamination, itself, whether or not the site is selected, might require the contamination to be addressed.

Risk Mitigation - A Phase II Environmental Assessment can be performed to better characterize the hazard. This assessment involves the collection of media samples, the testing of the samples in an appropriately accredited laboratory and then comparing the results to environmental media standards established by the state and/or Federal government. The sampling can include:

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- Building interiors.
- Soil samples from suspected impacted areas.
- Ground water samples and water level measurements.
- Surface water and sediment samples.
- Soil gas samples to evaluate for the potential for vapor intrusion.
- Background soil samples to establish base line conditions.
- Ecological conditions evaluation.
- Presence of historic fill.

If the Phase II Environmental Assessment identifies impacts over applicable standards, then further study is needed to delineate the impact and determine the risk associated with the impact. The Site Feasibility Assessment culminates in the selection of a Remedial Action, which includes the identification and engineering analysis of remedial action alternatives for the site which are cost-effective and consistent with the development requirements (i.e. proposed use, critical time schedule, funding goals). During this phase, remedial action objectives are identified, technologies or approaches that meet those objectives are screened, and detailed engineering analysis is conducted.

Another aspect of the feasibility assessment is to perform small tests of potential remedial treatment options on site specific samples. This is called bench scale treatability studies and involves exposing contaminated soil from the site to various types of treatment liquids and concentrations. This is most appropriate when considering an in situ remedial technology such as enhanced biodegradation, chemical oxidation or thermal desorption.

A Remedial Investigation (RI) can be performed, which includes the activities needed to collect data to characterize the horizontal and vertical extent of contamination; identify potential sources of continued contamination including the presence of "hot spots"; determine the surface and subsurface characteristics of the site including soil characteristics and depth to groundwater; and assess risk to human health and environment through the identification of paths of exposure and actual or potential receptors.

There are a wide range of remedial options available for cleaning up impacted sites. These range from simple excavation of impacted soil from a tank leak to complex multiple phases of injection of treatment liquids to remove concentrated VOCs. Various web sites are available that list remedial technologies and describe their application, cost and effectiveness. Several are:

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- Federal Remediation Technologies Roundtable (www.frtr.gov)
- Green Remediation Web (<http://www.clu-in.org/greenremediation/>)
- Interstate Technology & Regulatory Council (www.itrcweb.org)
- Brownfields and Land Revitalization Technology Support Center (www.Brownfieldstsc.org)

REFERENCES:

1. Brownfield Site Contamination Investigation, NJIT
(<http://www.njit.edu/tab/managing/pre-development/contamination-investigation.php>)
2. "Road Map to Understanding Innovative Technology Options for Brownfields Investigation and Cleanup," Based on the Fourth Edition published in September 2005 (EPA-542-B-05-001)
(<http://www.Brownfieldstsc.org/roadmap/home.cfm>)
3. The Brownfields and Land Revitalization Technology Support Center
(<http://www.Brownfieldstsc.org/>)

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OTHER SITE CHARACTERISTIC TEMPLATES

Features that Could Affect Development of Security Measures and Adequate Security Plans

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SITE CHARACTERISTIC: OTHER / Features that Could Affect Development of Security Measures and Adequate Security Plans

DESCRIPTION: According to 10 CFR 100.21(f), "Site characteristics must be such that adequate security plans and measures can be developed." A key parameter in this site characteristic is sufficient site area such that adequate security standoff distances can be established, and there are no public transportation routes that traverse the site.

IMPORTANCE: 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.

RISK: If the distance to the nearest exclusion area boundary is greater than 360 feet (110 meters), the site characteristics are not normally limiting with regard to the ability to develop adequate security plans. Additional design features, analyses, or other requirements may be necessary if the required standoff distances cannot be satisfied by the site layout and boundaries.

EVALUATION:

Acceptable Site

Challenged Site Requiring Further Evaluation

Site Not Suitable

DISCUSSION: Generally, a distance of about 360 feet (110 meters) 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 360 feet (110 meters), special measures or analyses may be needed to show that adequate security plans can be developed.

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 360 feet (110 meters) to a vital structure or vital equipment, special measures or analyses may be needed to show that adequate security plans can be developed.

If the site being evaluated is co-located with other facilities, or will have interfaces with other facilities, impediments and/or challenges to cyber security implementation should be considered and evaluated. For example, if onsite and/or offsite emergency

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planning communications will be integrated, cyber security requirements would apply.

Site Type - The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield“, or “existing nuclear power plant” site. If a candidate site is considered a “Brownfield” site and has experienced previous industrial use, or the site is associated with an existing nuclear power plant, existing security measures and plans may be available for review to determine acceptability of the additional of new nuclear plant capacity on the site. But, because the physical security measures and plans are unique to each site, and somewhat dependent on the type of facility technology being utilized (i.e., location of vital areas for the technology may differ), an analysis would still be necessary to adequately identify the risks to development of security measures and plans. The same strategy would be necessary for a “Greenfield” site.

Evaluation criteria - The site should be classified as “Acceptable Site” when the site is sufficiently large to accommodate the necessary standoffs (i.e., greater than 110 meters standoff), and there are no public roadways, waterways or railroads that traverse the site. There should be no significant anticipated cyber security challenges.

The site should be classified as “Challenged Site Requiring Further Evaluation” when the site boundary must be somewhat less than the generally acceptable standoff distance of 110 meters, or there are transportation routes that traverse the site, but where security measures to protect the plant are still considered possible; or if significant cyber security challenges and anticipated.

A “Site Not Suitable” evaluation might be warranted for an extremely small area site, with very short standoff distances to vital equipment areas.

For the evaluation parameters, evaluation criteria for identifying issues that could prevent establishment of adequate security measures or security plans should include:

- Site area
- Reactor plant layout or plot plan with identification of plant vital areas and equipment locations from the technology vendor(s), and
- Data that adequately describes the locations and distances from the candidate plant to nearby transportation routes (highways, railroads, waterways).

Risk - According to RG 4.7, if the distance to the nearest exclusion area boundary is greater than 360 feet (110 meters),

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and if nearby transportation routes pass farther than about 360 feet (110 meters) to a vital structure or vital equipment, the site characteristics are not normally limiting with regard to the ability to develop adequate security plans. Additional design features, analyses, or other requirements may be necessary if the required standoff distances cannot be satisfied by the site layout and boundaries.

Risk Mitigation - If the distance to the nearest exclusion area boundary is greater than 360 feet (110 meters), or if a transportation route passes closer than about 360 feet (110 meters) to a vital structure or vital equipment, special measures or analyses may be needed to show that adequate security plans can be developed.

REFERENCES:

1. 10 CFR 100.21, "Non-seismic siting criteria," paragraph 10 CFR 100.21(f)
2. U.S. Nuclear Regulatory Commission, Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations - Industrial, Military, and Transportation Facilities"
3. U.S. Nuclear Regulatory Commission, NUREG-0800, SRP 2.2.1-2.2.2, "Identification of Potential Hazards in Site Vicinity"
4. SECY 2007-0167, Regulation of Advanced Nuclear Power Plants; Statement of Policy
5. 10 CFR Part 73, Physical Protection of Plants and Materials; 10 CFR 73.55, "Requirements for Physical Protection of Licensed Activities in Nuclear Power Reactors Against Radiological Sabotage"
6. 10 CFR Part 73, Physical Protection of Plants and Materials; 10 CFR 73.54, "Protection of digital computer and communication systems and networks."

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OTHER SITE CHARACTERISTIC TEMPLATES

Sample Template

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NOTE to Evaluators

This is an example of the information that the template should include. There are two kinds of information to be included: (1) Site characteristic-related information; (2) a summary or description of the assessment data and methods used to perform the assessment.

(Identify the site characteristic using the hierarchical format shown below.)

SITE CHARACTERISTIC: *(Identify the site characteristic and whether it is related to health/safety, environmental, or other considerations.)*

DESCRIPTION: *(Describe the site characteristic, including descriptive information found in appropriate regulatory guidance documents, such as RGs (including RG 1.206, if a COLA is involved), NUREG-0800, 10 CFR sections, etc.*

The question to answer is “What are the key features of this characteristic to consider in the evaluation?” The emphasis is on existing regulatory considerations for obvious reasons: the same critical features that the NRC will evaluate should be evaluated herein. However, other considerations (e.g., economic) also might be identified.

If the description of the site characteristic would be different for different reactor technologies, then differentiate the discussion here.)

IMPORTANCE: *(Describe the site characteristic importance. The General Design Criteria might be applicable. However, use any information sources, including NRC SERs, your own expert knowledge, etc., to put the characteristic into perspective to provide a frame of reference for the evaluation in weighing relative importance of the various features of the characteristic.)*

RISK: *(Identify the major risks associated with failing to successfully meet the selected characteristic, as shown below, as well as the feasibility of risk-mitigation measures for various features of the parameter. For example, is the site feasible for constructing dams, dikes, drains, etc. (in the case of flooding), or might it be feasible to increase the elevation of the site using engineered fill, etc.*

Also, provide guidance for grading risks, such that an evaluation can be made. For example, PMF elevation = 5 ft below plant grade could be an “acceptable site.” PMF elevation > 5 ft above plant grade could mean “site not suitable.” There could be other gradations or scales, depending on the parameter and its features.)

- EVALUATION:**
- Acceptable Site**
 - Challenged Site Requiring Further Evaluation**
 - Site Not Suitable**

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DISCUSSION:

Site Type – (*The evaluation should identify the type of site being evaluated, i.e., a “Greenfield,” “Brownfield “ or existing nuclear power plant site. The evaluation should identify the unique applicability of site type-related differences, if any, for the treatment of this issue.)*

Evaluation criteria - (*Identify the criteria for each of the three possible evaluation outcomes. The evaluator is to determine the significant factor(s) applicable to their subject and articulate them in this section along with acceptance values or guidance for determination of acceptability and should be as specific and detailed as feasible. The Standard Review Plan (NUREG-0800) provides insight as to areas of review by the NRC Staff and should be consulted, as appropriate, to ensure that the evaluation is sufficiently comprehensive.*)

Note: There may be multiple features to be discussed for any particular characteristic.

(The evaluator should identify existing data and analyses that were used for the evaluation. Methods may be different for different site types, for example, an existing nuclear site or a “Brownfield site.”)

Note: There may be multiple features to be discussed for any particular characteristic.

Risk - (*The template should clearly articulate the risks factors associated with the analysis or assumptions. The discussion of each risk factor should include the relevance of the site type to the level of risk.*)

Note: There may be multiple features to be discussed for any particular parameter.

Risk Mitigation – (*The question that we are attempting to answer is “What do we do if we do not fully meet the evaluation criteria?”*

A risk mitigation/management strategy should be discussed here. What are the likely next step(s). Typically, they might involve additional investigation and might include field work such as obtaining borings for further analysis. They might also include obtaining additional data and performing calculation(s) or analysis.)

Note: There may be multiple features to be discussed for any particular site characteristic.

REFERENCES:

(Provide a list of all technical/regulatory references used in the preparation of the template, as well as known references that could aid the evaluation. The example below is not complete, in that it could include computer-modeling references, industry guidance, helpful websites, etc.)

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APPENDIX D

ADDENDUM TO EMERGENCY PLANNING EVALUATION TEMPLATE

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Evaluation Criteria	Evaluator Guidance	Evaluators Remarks
10 CFR 50		
50.33(g) (g) If the application is for an operating license or combined license for a nuclear power reactor, or if the application is for an early site permit and contains plans for coping with emergencies under § 52.17(b)(2)(ii) of this chapter, the applicant shall submit radiological emergency response plans of State and local governmental entities in the United States that are wholly or partially within the plume exposure pathway emergency planning zone (EPZ), ⁴ as well as the plans of State governments wholly or partially within the ingestion pathway EPZ. ⁵ If the application is for an early site permit that, under 10 CFR 52.17(b)(2)(i), proposes major features of the emergency plans describing the EPZs, then the descriptions of the EPZs must meet the requirements of this paragraph. Generally, the plume exposure pathway EPZ for nuclear power reactors shall consist of an area about 10 miles (16 km) in radius and the ingestion pathway EPZ shall consist of an area about 80 km (50 miles) in radius. The exact size and configuration of the EPZs surrounding a particular nuclear power reactor shall be determined in relation to the local emergency response needs and capabilities as they are affected by such conditions as demography, topography, land characteristics, access routes, and jurisdictional boundaries. The size of the EPZs also may be determined on a case-by-case basis for gas-cooled reactors and for reactors with an authorized power level less than 250 MW thermal. The plans for the ingestion pathway shall focus on such actions as are appropriate to protect the food ingestion pathway.	EPZ size is based on reactor design and power level. For light water reactors, the plume exposure pathway EPZ is approximately 16 km (10 miles) from the plant; the ingestion pathway EPZ is about 80 km (50 miles) in radius. For gas cooled reactors and reactors rated at less than 250 MW _t , the EPZs will be smaller. The evaluator should determine the assumed size of the EPZs based on the proposed technology. Based on the size of the EPZs, the evaluator should determine the jurisdictions potentially located within the EPZs. The evaluator should determine whether radiological emergency response plans are currently available for these jurisdictions. The following should be considered: <ul style="list-style-type: none"> • Availability of existing radiological emergency plans for the state or local jurisdictions. • Applicability of existing “all-hazards” plans related to nuclear plant offsite planning standards. • For an existing nuclear unit on the site, the existing onsite and offsite resources associated with emergency preparedness for the existing unit(s). 	

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	Evaluation Criteria	Evaluator Guidance	Evaluators Remarks
50.47(b)(1)	Organizational Control – Primary responsibilities for emergency response by the nuclear facility licensee, and by State and local organizations within the Emergency Planning Zones have been assigned, the emergency responsibilities of the various supporting organizations have been specifically established, and each principal response organization has staff to respond and to augment its initial response on a continuous basis. [NUREG-0654 II.A]	Applicant emergency plans will need to be developed if the feasibility study is on a Greenfield site. The evaluator should consider the location of the proposed nuclear reactor(s). The State and/or local emergency plans for a nuclear power plant emergency may not exist. Local resources may be limited and further evaluation could be required to determine recommendations related to supporting commercial nuclear power plant operations. These offsite resources include: <ul style="list-style-type: none"> • Local hospital and capabilities for handling radiological injuries. • Firefighting support. • Ambulance services availability. 	
50.47(b)(2)	Onsite Emergency Organization - On-shift facility licensee responsibilities for emergency response are unambiguously defined, adequate staffing to provide initial facility accident response in key functional areas is maintained at all times, timely augmentation of response capabilities is available and the interfaces among various onsite response activities and offsite support and response activities are specified. [NUREG-0654 II.B]	If a nuclear facility exists onsite, the evaluator should determine whether the existing organizational structure could be expanded to accommodate additional units. The type of reactor technology chosen should also be considered. For a Greenfield site, particularly when the proposed applicant does not currently operate other nuclear plants, the emergency response infrastructure will need to be developed and should be identified by the evaluator.	

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Evaluation Criteria		Evaluator Guidance	Evaluators Remarks
50.47(b)(3)	Emergency Response Support and Resources – Arrangements for requesting and effectively using assistance resources have been made, arrangements to accommodate State and local staff at the licensee’s near-site Emergency Operations Facility have been made, and other organizations capable of augmenting the planned response have been identified. [NUREG-0654 II.C]	The evaluator should determine whether local resources exist or are limited. Agreements may already be in place if nuclear units are currently in operation on the site. Written agreements will need to be established when the ESP or COL Application are developed. The level of cooperation expected from local support services, such as, fire/rescue, ambulance, law enforcement, hospitals, needs to be evaluated.	
50.47(b)(4)	Emergency Classification – A standard emergency classification and action level scheme, the bases of which include facility system and effluent parameters, is in use by the nuclear facility licensee, and State and local response plans call for reliance on information provided by facility licensees for determination of minimum initial offsite response measures. [NUREG-0654 II.D]	The evaluator should consider the type of reactor technology chosen. The emergency action level (EAL) scheme may be similar to existing schemes. However, the unique characteristics of the new reactor should be addressed in the development of EALs specific to the new plant and site.	

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	Evaluation Criteria	Evaluator Guidance	Evaluators Remarks
50.47(b)(5)	Notification Methods and Procedures – Procedures have been established for notification, by the licensee of State and local response organizations and for notification of emergency personnel by all response organizations; the content of initial and followup messages to response organizations and the public has been established; and means to provide early notification and clear instruction to the populace within the plume exposure pathway Emergency Planning Zone have been established. [NUREG-0654 II.E]	The evaluator should consider the presence of an existing nuclear power plant on the site and whether methods and procedures are already in place. For a Greenfield site, the evaluator should determine the presence of existing nuclear power plants in the local area or State. If State and local governments participate in emergency planning for an existing nuclear power plant, the existing methods and procedures would directly apply. If there is no plant currently located in the State, specific methods and procedures would need to be developed considering methods and procedures in use for other emergencies.	

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	Evaluation Criteria	Evaluator Guidance	Evaluators Remarks
50.47(b)(6)	Emergency Communications – Provisions exist for prompt communications among principal response organizations to emergency personnel and to the public. [NUREG-0654 II.F]	<p>The evaluator should consider the presence of an existing nuclear power plant on the site and whether communications equipment is already in place as well as the equipment identified and included in plant design.</p> <p>For a Greenfield site, the evaluator should determine the presence of existing nuclear power plants in the local area or State. If State and local governments participate in emergency planning for an existing nuclear power plant, the existing methods and procedures may directly apply and adequate communications equipment may already be in place. If there is no plant currently located in the State, specific methods and procedures would need to be developed considering methods and procedures in use for other emergencies.</p>	
50.47(b)(7)	Public Education and Information – Information is made available to the public on a periodic basis on how they will be notified and what their initial actions should be in an emergency (e.g., listening to a local broadcast station and remaining indoors), the principal points of contact with the news media for dissemination of information during an emergency (including the physical location or location) are established in advance, and procedures for coordinated dissemination of information to the public are established. [NUREG-0654 II.G]	The evaluator should consider the presence of an existing nuclear power plant on the site and whether these materials have already been developed. Additionally, the applicant may have a basis for this material previously developed for other nuclear power plants.	

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	Evaluation Criteria	Evaluator Guidance	Evaluators Remarks
50.47(b)(8)	Emergency Facility and Equipment – Adequate emergency facilities and equipment to support the emergency response are provided and maintained. [NUREG-0654 II.H]	<p>The evaluator should consider the presence of an existing nuclear power plant on the site and whether facilities and equipment are already in place and can be utilized by a new unit(s).</p> <p>If the applicant operates other nuclear power plants, the evaluator needs to consider if the Emergency Operations Facility will be site-specific or at a centralized location.</p> <p>For a Greenfield site, the evaluator should determine the presence of existing nuclear power plants in the local area or State. If State and local governments participate in emergency planning for an existing nuclear power plant, the evaluator should consider the offsite facilities and equipment already in place. If there is no plant currently located in the State, offsite facilities and equipment would need to be developed.</p>	

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	Evaluation Criteria	Evaluator Guidance	Evaluators Remarks
50.47(b)(9)	Accident Assessment – Adequate methods, systems and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency condition are in use. [NUREG-0654 II.I]	The evaluator should consider that much of this provision will be based on the technology chosen. For a Greenfield site, the evaluator should determine the presence of existing nuclear power plants in the local area or State. If State and local governments participate in emergency planning for an existing nuclear power plant, the evaluator should consider the capabilities and resources already in place. If there is no plant currently located in the State, offsite capabilities would need to be developed.	
50.47(b)(10)	Protective Response – A range of protective actions have been developed for the plume exposure pathway EPZ for emergency workers and the public. Guidelines for the choice of protective action during and emergency, consistent with Federal guidance, are developed and in place, and protective actions for the ingestion exposure pathway EPZ appropriate to the locale have been developed. [NUREG-0654 II.J]	The evaluator should consider the presence of an existing nuclear power plant on the site and whether methods and procedures are already in place. For a Greenfield site, the evaluator should determine the presence of existing nuclear power plants in the local area or State. If State and local governments participate in emergency planning for an existing nuclear power plant, the evaluator should consider the offsite methods and procedures already in place. If there is no plant currently located in the State, specific methods and procedures would need to be developed considering methods and procedures in use for other emergencies.	

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	Evaluation Criteria	Evaluator Guidance	Evaluators Remarks
50.47(b)(11)	Radiological Exposure Control – Means of controlling radiological exposures, in an emergency, are established for emergency workers. The means for controlling radiological exposure shall include exposure guidelines consistent with EPA Emergency Worker and Lifesaving Activity Protective Action Guides. [NUREG-0654 II.K]	<p>The evaluator should consider the presence of an existing nuclear power plant on the site and whether methods and procedures are already in place.</p> <p>For a Greenfield site, the evaluator should determine the presence of existing nuclear power plants in the local area or State. If State and local governments participate in emergency planning for an existing nuclear power plant, the evaluator should consider the offsite methods and procedures already in place. If there is no plant currently located in the State, specific methods and procedures would need to be developed considering methods and procedures in use for other emergencies.</p>	
50.47(b)(12)	Medical and Public Health Support – Arrangements are made for medical services for contaminated injured individuals. [NUREG-0654 II.L]	<p>The evaluator should consider the presence of an existing nuclear power plant on the site and whether methods and procedures are already in place.</p> <p>For a Greenfield site, the evaluator should determine the presence of existing nuclear power plants in the local area or State. If State and local governments participate in emergency planning for an existing nuclear power plant, the evaluator should consider the offsite methods and procedures already in place. If there is no plant currently located in the State, specific methods and procedures would need to be developed considering methods and procedures in use for other emergencies.</p>	

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	Evaluation Criteria	Evaluator Guidance	Evaluators Remarks
50.47(b)(13)	Recovery and Reentry Planning and Post-accident Operations – General plans for recovery and reentry are developed. [NUREG-0654 II.M]	<p>The evaluator should consider the presence of an existing nuclear power plant on the site and whether methods and procedures are already in place.</p> <p>For a Greenfield site, the evaluator should determine the presence of existing nuclear power plants in the local area or State. If State and local governments participate in emergency planning for an existing nuclear power plant, the evaluator should consider the offsite methods and procedures already in place. If there is no plant currently located in the State, specific methods and procedures would need to be developed considering methods and procedures in use for other emergencies.</p>	
50.47(b)(14)	Exercises and Drills – Periodic exercises are (will be) conducted to evaluate major portions of emergency response capabilities, periodic drills are (will be) conducted to develop and maintain key skills, and deficiencies identified as a result of exercises or drills are (will be) corrected. [NUREG-0654 II.N]	The evaluator should recognize that evaluated exercise schedules are established years in advance and a new plant, regardless of location, will impact states, locals, NRC, and FEMA exercise schedules. This is not necessarily a feasibility/suitability risk, but is worthy of evaluation.	

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	Evaluation Criteria	Evaluator Guidance	Evaluators Remarks
50.47(b)(15)	Radiological Emergency Response Training – Radiological emergency response training is provided to those who may be called on to assist in an emergency. [NUREG-0654 II.O]	<p>The evaluator should consider the presence of an existing nuclear power plant on the site and whether methods and procedures are already in place.</p> <p>For a Greenfield site, the evaluator should determine the presence of existing nuclear power plants in the local area or State. If State and local governments participate in emergency planning for an existing nuclear power plant, the evaluator should consider the offsite methods and procedures already in place. If there is no plant currently located in the State, specific methods and procedures would need to be developed considering methods and procedures in use for other emergencies.</p>	
50.47(b)(16)	Responsibility for the Planning Effort: Development, Periodic Review and Distribution of Emergency Plans – Responsibilities for plan development and review and for distribution of emergency plans are established, and planners are properly trained. [NUREG-0654 II.P]	<p>The evaluator should consider the presence of an existing nuclear power plant on the site and whether methods and procedures are already in place.</p> <p>For a Greenfield site, the evaluator should determine the presence of existing nuclear power plants in the local area or State. If State and local governments participate in emergency planning for an existing nuclear power plant, the evaluator should consider the offsite methods and procedures already in place. If there is no plant currently located in the State, specific methods and procedures would need to be developed considering methods and procedures in use for other emergencies.</p>	

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Evaluation Criteria		Evaluator Guidance	Evaluators Remarks
10 CFR 52			
52.17(b)(1)	The site safety analysis report must identify physical characteristics of the proposed site, such as egress limitations from the area surrounding the site that could pose a significant impediment to the development of emergency plans. If physical characteristics are identified that could pose a significant impediment to the development of emergency plans, the application must identify measures that would, when implemented, mitigate or eliminate the significant impediment.	<p>The evaluator should consider any impediments to evacuation including, but not limited to, the following:</p> <ul style="list-style-type: none"> • Inadequate roadway networks • Egress limitations from the immediate area of the site • The presence of large institutional or other special needs populations within the EPZ • Population density within the EPZ • Physical characteristics unique to the proposed site that may hinder evacuation <p>There is no minimum time required to evacuate the plume exposure pathway Emergency Planning Zone. The only requirement is that an estimate of the evacuation time be performed and physical characteristics unique to the proposed site that could pose impediments to the development of emergency plans be identified. Accordingly, a study of evacuation times and strategies provides an assessment that could identify impediments to the planning effort. Constructed properly, this study would also address how an impediment could be mitigated.</p>	
52.79(a)(21)	Emergency plans complying with the requirements of § 50.47 of this chapter, and 10 CFR Part 50, Appendix E.	The evaluator should consider compliance with applicable planning standards, listed under the 10 CFR 50 review.	

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	Evaluation Criteria	Evaluator Guidance	Evaluators Remarks
52.79(a)(22)	<p>(i) All emergency plan certifications that have been obtained from the State and local governmental agencies with emergency planning responsibilities must state that:</p> <p>(A) The proposed emergency plans are practicable;</p> <p>(B) These agencies are committed to participating in any further development of the plans, including any required field demonstrations; and</p> <p>(C) These agencies are committed to executing their responsibilities under the plans in the event of an emergency;</p> <p>(ii) If certifications cannot be obtained after sustained, good faith efforts by the applicant, then the application must contain information, including a utility plan, sufficient to show that the proposed plans provide reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency at the site.</p>	<p>The evaluator should consider whether agreements are already in place for nuclear units currently in operation on the site that could be extended to the new unit(s).</p> <p>Written agreements will need to be established for the new unit(s) when the ESP or COL Application are developed. The level of cooperation expected from State and local emergency management agencies will need to be evaluated.</p>	

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Other		
Public involvement	<p>Affected State and local agencies should be engaged early in the siting process to ensure their cooperation in the planning effort. Emergency planning is a highly visible aspect of commercial nuclear power plant licensing and operations and needs the explicit support from State and local elected officials and emergency management professionals.</p> <p>Early dialog with local volunteer fire/rescue services, law enforcement, and medical care facilities should also be established.</p> <p>Any outreach by applicant management to the public and elected officials should be considered. The results of these efforts provide useful information regarding public acceptance and associated suitability of the site.</p>	