U.S. NUCLEAR REGULATORY COMMISSION

DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER^{TM} iPWR DESIGN

2.4.7 ICE EFFECTS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of issues related to hydrology

Secondary - Organization responsible for the review of issues related to meteorology

I. AREAS OF REVIEW

This section of the Design-Specific Review Standard (DSRS), the hydrologic and hydraulic phenomena are reviewed to ensure that any potential hazard to the structures, systems, and components (SSCs) important to safety due to ice effects are considered in plant design.

This section is part of Chapter 2 of the DSRS, which discusses the site characteristics that could affect the safe design and siting of a plant. The staff reviews information presented by the applicant for a design certification (DC), early site permit (ESP), or combined license (COL) concerning hydrologic setting of the site as it relates to SSCs important to safety. This DSRS section applies to reviews performed for each of these types of applications. These reviews are based on information and analysis presented in the applicant's final safety analysis report (FSAR). The U.S Nuclear Regulatory Commission (NRC) staff's review and findings are described in the appropriate section of the final safety evaluation report (FSER).

The review covers the following specific areas:

1. Historical Ice Accumulation: The regional history and types of historical ice accumulations (i.e., ice jams, ice or glacial dams, wind-driven ice ridges, ice floes, frazil ice formation, etc.).

2. High and Low Water Levels: The potential effects of ice-induced high or low flow levels on SSCs and water supplies important to safety.

3. Ice Sheet Formation: The potential effects of a surface ice-sheet on reduction of the volume of available liquid water supply from rivers or reservoirs to SSCs important to safety.

4. Ice-Induced Forces and Blockages: The potential effects of ice-induced forces or blockage on SSCs important to safety.

5. Consideration of Other Site-Related Evaluation Criteria: The potential effects of seismic (including the effects of potential land subsidence) and non-seismic information on the postulated design basis and how they relate to worst-case icing scenario in the vicinity of site and the proposed plant site.

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6. Consideration of Cold-Region Hydrology: Cold-region hydrology can influence the timing and magnitude of runoff due to the presence of snow, ice, and frozen soil conditions. Consideration of these conditions and associated phenomena (such as rain-on-snow or ice, rain-on-frozen-soils, ice or glacial dam failure, backwater effects from ice or glacial dams, and other related phenomena) on flood (elevations and groundwater hydraulic heads should be included in the determination of design-basis events. Sites in the permafrost regions could potentially be impacted by freezing and thawing of land surfaces that could result in significant changes to the land surface. The formation of hydrate gas in the subsurface could also be a reason for concern. Specific areas of review in regions with permafrost and/or the occurrence of significant frost include:

   A. Description of the hydrologic processes in the permafrost region: The staff reviews information on the major hydrologic processes related to the presence of permafrost at a site. The staff also evaluates the likelihood of potential impacts of facility construction and operation on the permafrost (if present) and any potential effects (e.g., melting, possible ground subsidence, soil stability) at and around a site.

   B. Presence and extent of freezing and thawing at and in the vicinity of the site: The staff reviews information related to evidence of cyclical freezing and thawing of the surface and near-surface ground layer, its extent, and other relevant characteristics (e.g., the potential effects associated with rapid thawing and frost heaves) as presented in regional data obtained from a variety of sources.

   C. Presence of gas hydrates at and in the vicinity of the site: The staff reviews information related to the prevalence of gas hydrates (e.g., methane, ethane, carbon dioxide) at and in the vicinity of the site and their role in the local hydrologic processes. The review will also consider the ability of gas hydrates to impact safe operation of SSCs important to safety.

   D. Thermal gradient in the subsurface at and in the vicinity of the site: The staff reviews information related to the subsurface thermal gradient (including frost depth) at and in the vicinity of the site and its impact on site hydrologic processes and safe operation of SSCs important to safety.

7. Consideration of Significant Frost and Permafrost Region Hydrology: Regions subject to the occurrence of significant frost (and its cyclical freezing and thawing) and those characterized by the presence of permafrost pose a particularly unique set of design and environmental challenges. If a potential site is located in such a region, the safety review under this DSRS section will also focus on the characterization and evaluation of the effects of these conditions on hydrologic processes that can influence both surface water flooding and groundwater hydraulic heads. Consideration of the potential effects of these characteristics from an engineering standpoint will be addressed in the reviews under DSRS Chapter 3.

8. Additional Information for Title 10 of the *Code of Federal Regulations* (10 CFR), Part 52 Applications: Additional information will be presented dependent on the type of application. For a COL application, the additional information is dependent on whether the application references an ESP, a DC, both, or neither. Information requirements are

prescribed within the “Contents of Application” sections of the applicable subparts to 10 CFR Part 52.

Review Interfaces

Other DSRS or Standard Review Plan (SRP) sections interface with this section as follows:

1. Sections 2.4.0, 2.4.2 – 2.4.6, 2.4.8 and 2.4.9 address the flood-producing phenomena individually and in combination to determine the design-basis flood.

2. Flooding protection measures, if required for SSCs important to safety, are reviewed in DSRS Section 2.4.10 “Flood Protection Requirements.”

3. Potential changes to permafrost soils from construction and operation of the plant and the effect of these changes on groundwater processes are reviewed in DSRS Section 2.4.12.

4. The identification of SSCs important to safety that should be protected against the effects of flooding is performed under DSRS Section 3.4.1, "Internal Flood Protection for Onsite Equipment Failure."

5. The review of the design of seismic Category I structures to withstand the effects of flooding that could result from ice blockage, is performed under DSRS Section 3.4.2, ”Analysis Procedures.”

6. The review to ensure that adverse environmental conditions, including freezing, will not preclude the safety function of the ultimate heat sink (UHS) is performed under DSRS Section 9.2.5, ”Ultimate Heat Sink.”

7. For DC applications and COL applications referencing a DC rule or DC application, review of the site parameters in the Design Control Document (DCD) Tier 1 and Chapter 2 of the DCD Tier 2[1] submitted by the applicant is performed under SRP Section 2.0, ”Site Characteristics and Site Parameters.” Review of site characteristics and site-related design parameters in ESP applications or in COL applications referencing an ESP is also performed under SRP Section 2.0.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. 10 CFR Part 100, as it relates to identifying and evaluating hydrologic features of the site. The requirements to consider physical site characteristics in site evaluations are specified in 10 CFR 100.20(c) and 10 CFR 100.21(d).

2. 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2 as it relates to consideration of the most severe of the natural phenomena that have been historically

[1] Additional supporting information of prior DC rules may be found in DCD Tier 2 Section 14.3.

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.

3. 10 CFR 52.17(a)(1)(vi), for ESP applications, and 10 CFR 52.79(a)(1)(iii), for COL applications, as they relate to the hydrologic characteristics of the proposed site with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

DSRS Acceptance Criteria

Specific DSRS acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are set forth below. The DSRS is not a substitute for the NRC's regulations, and compliance with it is not required. Identifying the differences between this DSRS section and the design features, analytical techniques, and procedural measures proposed for the facility, and discussing how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria, is sufficient to meet the intent of 10 CFR 52.47(a)(9), "Contents of applications; technical information." The same approach may be used to meet the requirements of 10 CFR 52.17(a)(1)(xii) and 10 CFR 52.79(a)(41), for ESP and COL applications, respectively.

Regulatory Guide (RG) 1.27 describes the applicable ultimate heat sink capabilities.

RG 1.29 identifies SSCs important to safety.

RG 1.59, as supplemented by best current practices, provides guidance for developing the flood design bases.

RG 1.102 describes acceptable flood protection to prevent the SSCs important to safety from being adversely affected.

1. Historical Ice Accumulation: The application should include a complete history of ice formation at locations that may result in ice-induced hazards at the site. A thorough listing of types of ice formations (ice jams, ice or glacial dams, ice floes, ridges, frazil, frozen soils, etc.), locations and durations of these formations, and descriptions of hydrometeorological characteristics accompanying these formations should be provided that are sufficient to establish the history of ice-formation that may result in ice-induced hazards at the site.

2. High and Low Water Levels: The application should include estimates of water levels resulting from potential flooding or low flows caused by ice formations. Flooding from collapse of an upstream ice or glacial dam or an ice jam should be considered. Effects of frozen soils and permafrost on floods should be considered. Backwater effects from a downstream ice or glacial dam or an ice jam that may result in flooding at the proposed site should also be considered. The suggested criteria of RG 1.27 apply when the water supply comprises part of the UHS.

3. Ice Sheet Formation: The application should include estimates of the most severe ice-sheet formation in rivers or water storage reservoirs. The reduction in liquid water supply from rivers or reservoirs due to the presence of the ice sheet should be estimated. The suggested criteria of RG 1.27 apply when the water supply comprises part of the UHS.

4. Ice-induced Forces and Blockages: The application should provide estimates of the most severe ice-induced forces on SSCs important to safety. The forces resulting from the most severe ice sheet interacting with SSCs important to safety should be estimated. An assessment regarding formation of frazil ice at and in the vicinity of the site is needed. Blockages from frazil of safety-related intakes should be assessed. Ice blockage of rivers, streams, and estuaries, both upstream and downstream of the site, should be determined. The suggested criteria of RG 1.27 apply when the water supply comprises part of the UHS.

5. Consideration of Other Site-Related Evaluation Criteria: The application should demonstrate that the potential effects of site-related proximity, seismic (including the effects of potential land subsidence), and non-seismic information as they relate to worst-case icing scenarios adjacent to and on the plant site and site regions are appropriately taken into account.

6. Consideration of Cold-Region Hydrology: The application should indicate if cold-region hydrology is applicable to the site or provide a reason for not considering it as a cold-region site. (This could be a statement such as "the site is located in a sub-tropical climatic region," along with supporting documentation.) Otherwise, the characteristics and potential effects of snow, ice, frozen soils, and glacial conditions, should be considered for ice-induced hazards, including flooding, for SSCs important to safety. Consideration of these conditions and associated phenomena (such as rain-on-snow, rain-on-frozen-soil, ice or glacial dam failure, backwater effects from ice or glacial dams, and other related phenomena) on Probable Maximum Flooding (PMF) elevations and groundwater hydraulic heads should be included in the determination of design-basis events.

7. Consideration of Significant Frost and Permafrost Region Hydrology: The application should indicate whether the hydroclimatic factors relevant for a site located in a region subject to the occurrence of significant frost and/or the presence of permafrost has been adequately addressed. If site characteristics and consideration of the potential effects in such regions are not presented in the application, then the justification for not doing so needs to be provided accordingly. For sites located in such regions, the application should include information on related hydrologic processes, biogeochemical processes that indicate the presence of gas hydrates, characteristics of thermal gradients and frost depth, freezing and thawing cycles in the surface and near-surface ground-layer, their extent and the effects associated with rapid thawing and frost heaves as evidenced by regional records and published information, the likelihood of potential impacts of facility construction and operation on the permafrost (if present) and any potential related effects (e.g., melting, possible ground subsidence, soil stability) at and around a site. Site hazards resulting from permafrost thawing need to be included in the application.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this DSRS section is discussed in the following paragraphs:

1. Pursuant to GDC 2, nuclear power plant SSCs important to safety shall be designed to withstand the effects of natural phenomena such as earthquake, tornado, hurricane, flood, tsunami, and seiche without loss of capability to perform their safety functions. The criterion further specifies that the design bases for these SSCs shall reflect the following:

A. Appropriate consideration of the most severe natural phenomena historically reported for the site and its surrounding area, with sufficient margin for the limited accuracy, quantity, and time period in which the historical data have been accumulated;

B. Appropriate combinations of the effects of normal and accident conditions with those of the natural phenomena; and

C. The importance of the safety functions to be performed.

The first specification was adopted in recognition of the relatively short history available for severe natural phenomena on the North American continent and, as a result, the potential for underestimating the severity of such events, based on probabilistic considerations only. This problem can be avoided by using a deterministic approach to assess design basis events. Such an approach will account for the practical physical limitations of natural phenomena to contribute to the severity of a given event.

This criterion is relevant to this DSRS section in that it addresses the potential effects of ice on the hydrologic characteristics of the plant site. In general terms, it also specifies the amount of conservatism that should be used to determine the severity of ice-related phenomena for the purpose of assessing the adequacy of the design bases used for SSCs important to safety. This is a similar standard as that applied in reviewing ESPs or COLAs.

Meeting the requirements of GDC 2 provides assurance that SSCs important to safety have been designed to withstand the most severe icing phenomena likely to occur.

2. Section 100.20(c) of 10 CFR Part 100 require that physical characteristics of a site (including seismology, meteorology, geology, and hydrology) be taken into account when determining its acceptability for a nuclear power reactor.

To satisfy the hydrologic requirements of 10 CFR Part 100, the applicant's FSAR should contain a description of all icing phenomena with a potential to result in adverse effects to the intake structure or other SSCs important to safety. Historical information for ice-related characteristics associated with the site and region should be described, and an analysis should be performed to determine the potential for flooding, low water, or ice damage to SSCs important to safety. The analysis should be sufficient to evaluate the site's acceptability and to assess the potential for those characteristics to influence the design of the plant SSCs important to safety.

Meeting this requirement provides assurance that SSCs important to safety are designed to withstand the effects of potentially severe icing conditions.

III. REVIEW PROCEDURES

The procedures outlined below are used to review ESP applications and COL applications that do not reference an ESP to determine whether data and analyses for the proposed site meet the acceptance criteria given in Subsection II of this DSRS section. As applicable, reviews of COLs include a determination on whether the content of technical specifications related to is acceptable and whether the technical specifications reflect consideration of any identified unique conditions.

These review procedures are based on identified DSRS acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

1. In accordance with 10 CFR 52.47(a)(8),(21), and (22), for new reactor license applications submitted under Part 52, the applicant is required to (1) address the proposed technical resolution of unresolved safety issues (USIs) and medium- and high-priority generic safety issues (GSIs) that are identified in the version of NUREG-0933 current on the date 6 months before application and that are technically relevant to the design; (2) demonstrate how the operating experience insights have been incorporated into the plant design; and, (3) provide information necessary to demonstrate compliance with any technically relevant portions of the Three Mile Island requirements set forth in 10 CFR 50.34(f), except paragraphs (f)(1)(xii), (f)(2)(ix), and (f)(3)(v). These cross-cutting review areas should be addressed by the reviewer for each technical subsection and relevant conclusions documented in the corresponding FSER section.

2. Historical Ice Accumulation: Publications of the National Oceanic and Atmospheric Administration (NOAA), the United States Geologic Survey (USGS), the U.S. Army Corps of Engineers (USACE), USACE Engineer Research and Development Center Cold Regions Research and Engineering Laboratory (CRREL), and other sources are used to identify the history and potential for ice formation in the region. Historical maximum depths of icing should be noted, as well as mass and velocity of any large floating ice bodies. The phrase “historical low water ice affected” or similar phrases in streamflow records (USGS and State publications) will alert the reviewer to the potential for ice effects.

   Applicable literature describing historical occurrences of icing in the region is reviewed to determine if icing protection should be considered in the design of SSCs important to safety. If considered necessary, the most likely types of icing conditions (floating ice, river blockage by ice buildup, snow, frozen soils, frazil ice, etc.) are listed, and the potential impact on plant design of each type is identified. Criteria of the USACE and others provide a means of assessing icing impact and methods of mitigating adverse effects. For each type of icing condition, preliminary independent conservative estimates of the worst case will be made by either statistical or deterministic techniques.

3. High and Low Water Levels: The regional ice or glacial dam and ice jam formation history (e.g., from the USACE historical ice jam database) should be described to enable an independent determination of the need for including ice effects in the design basis for high and low water levels.

   If the applicant’s estimates of ice effects are comparable to the staff’s preliminary bounding analysis, the staff should concur with the applicant’s estimates. If the preliminary bounding analysis indicates the applicant’s estimates of ice effects are not comparable to the staff’s estimates, the staff’s analysis should be repeated using more realistic techniques.

4. Ice Sheet Formation: Accumulated freezing degree-days data estimated from air temperatures available from CRREL may be analyzed to verify that only minimal ice sheet formation occurs in rivers or reservoirs even during severe winters. In such cases, further analysis may not be needed. If ice formation is not minimal, techniques for estimating ice sheet thickness in rivers or reservoirs such as those described in USACE

publication EM 1110-2-1612, “Engineering and Design - Ice Engineering,” can be used in combination with CRREL accumulated freezing degree-days data and conservative assumptions of the ice initiation date. The volume of liquid water available under the most severe ice sheet formation condition should be sufficient to meet water supply requirements for SSCs important to safety.

Similarly, with regards to evaluating the potential for water freezing in a UHS-related water storage facility (if applicable) or other SSC important to safety, the maximum accumulated degree-days below freezing, recorded in the site region during the winter (or during the worst-case freezing spell in warmer climates), and the maximum estimated ice thickness are considered to be reasonably conservative site characteristics for this purpose. Data available from the CRREL and methodologies described in “Engineering and Design - Ice Engineering,” referenced above are likewise acceptable.

Acceptable meteorological data sources should not be constrained to CRREL databases alone or to measurements made at first-order National Weather Service (NWS) stations. Data available from National Climatic Data Center (NCDC) cooperative (Coop) observer network stations should also be considered, if only a single weather element (i.e., ambient temperature) is needed to estimate ice thickness, and because the station density for NCDC Coop observation locations is far greater than for first-order NWS stations and thus NCDC Coop observation stations are likely to be located closer to and more representative of conditions at a proposed reactor site.

To the extent possible, and consistent with RG 1.27, at least a 30-year period of record (POR) for the meteorological database should be used. PORs of shorter duration should be justified by the applicant as to the long-term representativeness of temperature conditions (in terms of magnitude and persistence) that can reasonably be expected to occur at the proposed site. Resources for the staff’s evaluation may include the NCDC’s: Global Historical Climatology Network, Cooperative Summary of the Day (TD3200) series, and the U.S. Summary of Day Climate Data (DS 3200/3210) data bases, depending on the POR and how the data are archived by and accessible from the NCDC for the duration used.

5. Ice-Induced Forces and Blockages: If floating ice is prevalent, based on regional icing history, potential impact forces on the SSCs important to safety should be considered in the design basis. The dynamic loading caused by floating ice should be included in the DSRS Section 3.4.2 “Analysis Procedures.” The staff’s review in this section should provide site characteristics sufficient for the analysis in DSRS Section 3.4.2.

   If ice blockage of the river or estuary is possible, it should be demonstrated that the resulting water level in the vicinity of the site has been considered in establishing the flood (e.g., from collapse of an ice or glacial dam) and water supply design bases (e.g., low water downstream of ice jams) of SSCs important to safety. If this low water level would adversely affect water supply for SSCs important to safety, it should be demonstrated that an alternative water supply will not also be similarly and adversely affected.

   If icing has not been severe, based on regional icing history, design considerations should be presented (e.g., return of a portion of low-grade heat to the intake) to ensure that icing or ice blockage of intake screens (e.g., due to frazil ice) and pumps will not adversely affect SSCs and water supplies important to safety.

At sites or in site regions where more detailed analysis is needed to ascertain the most severe ice-induced hazard, the review verifies that the following icing potential site characteristics have been provided:

A. maximum accumulated freezing degree-days (assists in design of SSCs exposed to the effects of ice)

B. a determination of whether the site or the site region supports formation of ice or glacial dams, ice jams, and frazil ice

C. a determination of whether snow or frozen soil conditions occur at the site or in the site region.

6. Consideration of Other Site-Related Evaluation Criteria: Subpart B of 10 CFR Part 100 describes site-related proximity, seismic (including the effects of potential land subsidence), and non-seismic evaluation criteria for power reactor applications. The staff's review should include evaluation of pertinent information to determine if these criteria are appropriately used in postulation of the worst-case icing scenario at the proposed plant site.

7. Consideration of Cold-Region Hydrology: Rain on a snow pack has the potential to produce large runoff volumes. The peak runoff discharge depends on several factors including (but not limited to) the depth of snow pack, the precipitation intensity, and the elevation of the atmospheric freezing level. The timing of peak runoff from available records should be evaluated in this context, and the potential for probable maximum precipitation (PMP) onto snow packs evaluated. Mountainous regions in cold climates can be covered by glaciers and ice fields, which under certain conditions produce glacial lakes. The potential for formation of such features, if found to be present, and the potential for failure of glacial dams should be evaluated. In regions where soils can be expected to be frozen for significant times of the year, estimation of runoff from PMP events should consider appropriately low precipitation losses. Runoff routing methods should also account for frozen conditions, where applicable.

8. Consideration of Significant Frost and Permafrost Hydrology: Far northern latitudes may harbor permafrost at depths ranging from a few feet to over 1,000 feet. Permanently frozen conditions in the permafrost region affect the generation of flood and subsurface hydraulic head. In such regions, potential impacts to the permafrost layer (e.g., melting, possible ground subsidence, soil stability) due to construction and operation may alter surface and groundwater hydrology of the site. Thawing of the permafrost region affects the hydrologic processes significantly through changes in the geomorphic settings of the area and associated changes in the hydrologic processes. The hydrologic modifications due to any identified impacts should be evaluated based on current science and data.

   For a site located in a region subject to the occurrence of significant frost (whether a permafrost layer is present or not), the staff also evaluates the applicant's characterization of hydrologic processes, biogeochemical processes indicating the presence of gas hydrates, thermal gradients, frost depth, and freezing / thawing cycles in the surface and near-surface ground-layer, and their extent, and the effects associated with rapid thawing and frost heaves (as applicable), or alternatively the justification for why such consideration is not necessary.

   Resources for the staff's evaluation may include: the USACE Engineer Research and Development Center CRREL for Hydrology and Hydraulics at

http://www.crrel.usace.army.mil/technical_areas/hh/, the National Snow and Ice Data Center at http://nsidc.org/, and the University of Alaska – Fairbanks Geophysical Institute Permafrost Laboratory at http://permafrost.gi.alaska.edu/content/data-and-maps.

9. Review Procedures Specific to 10 CFR Part 52 Application Type

A. ESP Reviews: Subpart A to 10 CFR Part 52 specifies the requirements and procedures applicable to the Commission's review of an ESP application for approval of a proposed site. Information required in an ESP application includes a description of the site characteristics and design parameters of the proposed site. The scope and level of detail for reviewing data parallel those used for a COL review.

In the absence of certain circumstances, such as a compliance or adequate protection issue, 10 CFR 52.39 precludes the staff from imposing new site characteristics, design parameters, or terms and conditions on the ESP at the COL stage. Accordingly, the reviewer should ensure that all physical attributes of the site that could affect the design basis of SSCs important to safety are reflected in the site characteristics, design parameters, or terms and conditions of the ESP.

B. Standard Design Certification Reviews: DC applications do not contain general descriptions of site characteristics because this information is site-specific and will be addressed by the COL applicant. However, pursuant to 10 CFR 52.47(a)(1), a DC applicant must provide site parameters postulated for the design. The reviewer verifies that:

i. The postulated site parameters are representative of a reasonable number of sites that have been or may be considered for a COL application;

ii. The appropriate site parameters are included as Tier 1 information. This convention has been used by previous DC applicants. Additional guidance on site parameters is provided in SRP Section 2.0;

iii. Pertinent parameters are stated in a site parameters summary table; and

iv. The applicant has provided a basis for each of the site parameters.

C. COL Reviews: For a COL application referencing a certified standard design, the NRC staff reviews that application to ensure that sufficient information is presented to demonstrate that the characteristics of the site fall within the site parameters specified in the DC rule. Should the actual site characteristics not fall within the certified standard design site parameters, the COL applicant will need to demonstrate by some other means that the proposed facility is acceptable at the proposed site. This might be done by re-analyzing or redesigning the proposed facility.

For a COL application referencing an ESP, NRC staff reviews the application to ensure the applicant provides sufficient information to demonstrate that the design of the facility falls within the site characteristics and design parameters specified in the ESP as applicable to this DSRS section. In accordance with 10 CFR 52.79(b)(2), should the design of the facility not fall within the site

characteristics and design parameters, the application shall include a request for a variance from the ESP that complies with the requirements of 10 CFR 52.39 and 10 CFR 52.93.

In addition, long-term environmental changes and changes to the region resulting from human or natural causes may have introduced changes to the site characteristics that could be relevant to the design basis. In the absence of certain circumstances, such as a compliance or adequate protection issue, 10 CFR 52.39 precludes the staff from imposing new site characteristics, design parameters, or terms and conditions on the ESP at the COL stage. Consequently, a COL application referencing an ESP need not include a re-investigation of the site characteristics that have previously been accepted in the referenced ESP. However, in accordance with 10 CFR 52.6, "Completeness and Accuracy of Information," the applicant or licensee is responsible for identifying changes of which it is aware, that would satisfy the criteria specified in 10 CFR 52.39. Information provided by the applicant in accordance with 10 CFR 52.6(b) will be addressed by the staff during the review of a COL application referencing an ESP or a DC.

For a COL application referencing either an ESP or DC or both, the staff should review the corresponding sections of the ESP and DC FSER to ensure that any ESP conditions, restrictions to the DC, or COL action items identified in the FSERs are appropriately handled in the COL application.

For a COL application referencing either an ESP or DC or both, the staff has issued additional guidance for review of COL items that cannot be resolved prior to issuance of the license in Interim Staff Guidance 015 (ISG-015). A COL applicant must provide all information in the COL application that is necessary for the staff to make the findings required to issue the license. Therefore, it may be necessary for the staff to partially close certain COL action or information items noted in an ESP or a DC, or both. The staff should identify the remaining portion of the COL items associated with information that is not necessary to issue the license as post-licensing commitments.

IV. EVALUATION FINDINGS

The review should document the staff's evaluation of site characteristics against the relevant regulatory criteria. The evaluation should support the staff's conclusions as to whether the regulations are met. The reviewer should state what was done to evaluate the applicant's FSAR. The staff's evaluation may include verification that the applicant followed applicable regulatory guidance, performance of independent calculations, and/or validation of appropriate assumptions. The reviewer may state that certain information provided by the applicant was not considered essential to the staff's review and was not reviewed by the staff. While the reviewer may summarize or quote the information offered by the applicant in support of its application, the reviewer should clearly articulate the bases for the staff's conclusions.

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's FSER. The reviewer also states the bases for those conclusions.

1. COL Reviews

The following statements in the FSER should be preceded by a summary of the site characteristics and postulated site parameters used for the plant:

> As set forth above, the applicant has presented and substantiated information relative to the ice effects important to the design and siting of this plant. The staff has reviewed the information provided and, for the reasons given above, concludes that the identification and consideration of the potential for ice flooding, ice blockage of water intakes, ice forces on structures, and the minimum low water levels (from upstream ice blockage) are acceptable and meet the requirements of [10 CFR Part 50, Appendix A, GDC 2 or 10 CFR 52.79, as applicable] and 100.20(c), with respect to determining the acceptability of the site.
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> The staff finds that the applicant has considered the appropriate site phenomena for establishing the design bases for SSCs important to safety. The staff has generally accepted the methodologies used to determine the potential for ice formation and blockage reflected in these site characteristics, as documented in FSERs for previous licensing actions. Accordingly, the staff concludes that the use of these methodologies results in site characteristics containing margin sufficient for the limited accuracy, quantity, and period of time in which the data have been accumulated. The staff concludes that the identified site characteristics meet the requirement(s) of [10 CFR Part 50, Appendix A, GDC 2 or 10 CFR 52.79, as applicable] and 10 CFR 100.20(c), with respect to establishing the design basis for SSCs important to safety.

2. ESP Reviews

The following statements in the FSER should be preceded by a summary of the site characteristics and design parameters to be included in any ESP that might be issued for the proposed site:

> As set forth above, the applicant has presented and substantiated sufficient information pertaining to the identification and evaluation of ice effects at the proposed site. Section 2.4.7, “Ice Effects,” of the Design-Specific Review Standard for mPower™ Integral Pressurized Water Reactor (iPWR) Design, provides that the site FSAR should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating ice effects at the site. Further, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area while describing the hydrologic interface of the plant with the site, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. The staff has generally accepted the methodologies used to determine the severity of the phenomena reflected in these site characteristics, as documented in FSERs for previous licensing actions. Accordingly, the staff concludes that the use of these methodologies results in site characteristics containing sufficient margin for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the site characteristics previously identified are acceptable for use in establishing the design bases for SSCs important to safety, as may be proposed in a COL application.
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> Therefore, the staff concludes that the identification and consideration of the site characteristics related to ice effects set forth above are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d).

In view of the above, the staff finds the applicant's proposed site characteristics related to ice effects for inclusion in an ESP for the applicant's site, should one be issued, to be acceptable.

3. Design Certification Reviews

The following statement in the FSER should be preceded by a list of the applicable site parameters used for the plant:

> The NRC staff acknowledges that the applicant has selected the site parameters referenced above for plant design inputs (a subset of which is included as Tier 1 information) and that they are representative of a reasonable number of sites that have been or may be considered for a COL application. Icing effects are site-specific and will be addressed by the COL applicant. This should include the provision of information sufficient to demonstrate that the design of the plant falls within the site parameters specified by the siting review.

V. IMPLEMENTATION

The staff will use this DSRS section in performing safety evaluations of mPower™-specific DC, COL, or ESP applications submitted by applicants pursuant to 10 CFR Part 52. The staff will use the method described herein to evaluate conformance with Commission regulations.

Because of the numerous design differences between the mPower™ and large light-water nuclear reactor power plants, and in accordance with the direction given by the Commission in SRM- COMGBJ-10-0004/COMGEA-10-0001, "Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews," dated August 31, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML102510405), to develop risk-informed licensing review plans for each of the small modular reactor (SMR) reviews including the associated pre-application activities, the staff has developed the content of this DSRS section as an alternative method for mPower™-specific DC, COL, or ESP applications submitted pursuant to 10 CFR Part 52 to comply with 10 CFR 52.47(a)(9), "Contents of applications; technical information."

This regulation states, in part, that the application must contain "an evaluation of the standard plant design against the SRP revision in effect 6 months before the docket date of the application." The content of this DSRS section has been accepted as an alternative method for complying with 10 CFR 52.47(a)(9) as long as the mPower™ DCD FSAR does not deviate significantly from the design assumptions made by the NRC staff while preparing this DSRS section. The application must identify and describe all differences between the standard plant design and this DSRS section, and discuss how the proposed alternative provides an acceptable method of complying with the regulations that underlie the DSRS acceptance criteria. If the design assumptions in the DC application deviate significantly from the DSRS, the staff will use the SRP as specified in 10 CFR 52.47 (a)(9). Alternatively, the staff may supplement the DSRS section by adding appropriate criteria in order to address new design assumptions. The same approach may be used to meet the requirements of 10 CFR 52.17 (a)(1)(xii) and 10 CFR 52.79 (a)(41), for ESP and COL applications, respectively.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, GDC 1, "Quality Standards and Records."

2. 10 CFR Part 50, Appendix A, GDC 2, ”Design Bases for Protection Against Natural Phenomena.”

3. 10 CFR Part 52, ”Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants.”

4. 10 CFR Part 100, ”Reactor Site Criteria.”

5. ANSI/ANS-2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites" (1992). Historical Technical Reference.

6. ”Engineering and Design - Ice Engineering,” EM 1110-2-1612, U.S. Army Corps of Engineers, Washington, DC, 2002 or later edition.

7. Final Interim Staff Guidance ESP/DC/COL-ISG-015, "Post-Combined License Commitments." January 21, 2010. Accession Number: ML093561416.

8. RG 1.27, ”Ultimate Heat Sink for Nuclear Power Plants.”

9. RG 1.29, ”Seismic Design Classification.”

10. RG 1.59, ”Flood Design Basis for Nuclear Power Plants.” Historical Technical Reference.

11. RG 1.70,”Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition).”

12. RG 1.102, ”Flood Protection for Nuclear Power Plants.”

13. RG 1.206,”Combined License Applications for Nuclear Power Plants.” (LWR Edition).