

Proposed - For Interim Use and Comment



U.S. NUCLEAR REGULATORY COMMISSION **DESIGN-SPECIFIC REVIEW STANDARD FOR mPOWER™ iPWR DESIGN**

2.4.0 HYDROLOGY REVIEW

REVIEW RESPONSIBILITIES

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

Secondary - None

I. AREAS OF REVIEW

Section 2.4 is part of Chapter 2 of the Design-Specific Review Standard (DSRS), which provides guidance for the U.S. Nuclear Regulatory Commission (NRC) staff's review of the site characteristics that could affect the safe design and siting of a nuclear power plant. The staff reviews information presented by the applicant for a design certification (DC), early site permit (ESP), or combined license (COL) concerning the hydrologic setting of the site as it relates to structures, systems, and components (SSCs) important to safety. This DSRS section applies to reviews performed for each of these types of applications.

This section provides guidance for staff's review of hydrologic site parameters important to safety. In the case of DCs the review determines whether the reactor specific parameters are presented and are appropriate with acceptable coverage for the continental U.S. In the case of ESPs the review determines whether the plant parameter envelopes (PPEs) are presented and are acceptable in comparison with the bounding parameters of existing reactor types. In the case of COL applications the review determines whether a comparison of these site characteristics with the reactor specific design parameters has been presented and whether there is a need for departure from the design control document parameters. This section will also present descriptive and tabulated information on key site parameters such as maximum precipitation, design basis flood, maximum groundwater level and other relevant site parameters. Description of the various flood causing phenomena considered in establishing the design basis flood for the site will also be presented in this section including the criteria used in determining the appropriate combination of flood causing phenomena. The information presented in this section needs to be consistent with the discussions presented in the other sections of the COL application, ESP, or DC as appropriate.

Hydrologic site characteristics and hydrologic processes that are important in understanding the plant's interface with the hydrosphere are presented in DSRS Section 2.4.1. Detailed information on flood causing phenomena is presented in DSRS Sections 2.4.2, through 2.4.9, while the need for flooding protection mechanisms is discussed in DSRS section 2.4.10. The necessary procedures to be implemented in the event of an emergency are presented in DSRS section 2.4.14. Although topical information may appear in the applicant's final safety analysis report (FSAR) Sections 2.4.3 through 2.4.9, the types of events considered and the controlling event are summarized in this DSRS section. Guidance on the review of specific topics is presented in DSRS Sections 2.4.2 through 2.4.14.

II. SUMMARY OF TOPICAL REVIEW AREAS

Flood Producing Phenomena

Information on flood producing phenomena is to be presented in order to meet the requirements of Title 10 of *Code of Federal Regulations* (10 CFR), Part 50, Appendix A, General Design Criterion (GDC) 2, 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 4, 10 CFR 52.17(a)(vi) for ESP applications, 10 CFR 52.79 (a)(1)(iii) for COL applications as they relate to hydrologic characteristics of the site, and 10 CFR Part 100 as it relates to identifying and evaluating hydrologic features of the site. Combined events as described herein will be used to determine the design basis flood for the site. Details of the flood producing phenomena to be considered include the following.

1. Stream Flooding. The staff reviews the probable maximum flood (PMF) with coincident wind induced waves, considering dam failure potential due to inadequate capacity, inadequate flood discharge capability, or existing physical condition. Details of the flooding analysis are presented in DSRS Sections 2.4.2 and 2.4.3 and will also be presented in the appropriate sections of applicant's FSAR. The review areas include the following:
 - A. The staff reviews the PMF with coincident wind induced waves, considering dam failure potential due to inadequate capacity, inadequate flood discharge capability, or existing physical condition.
 - B. The staff reviews ice jams, both independently and coincident with a winter probable maximum storm.
 - C. The staff reviews tributary drainage area PMF potential.
 - D. The staff reviews combinations of less severe river floods, coincident with surges and seiches.
2. Seismically- or Non-seismically- Induced Dam Failures (or Breaches). The staff reviews information related to flooding at the site from seismically induced and non-seismically induced dam failure scenarios. The review considers existing and proposed dams and other water retaining structures upstream of the site, downstream of the site and at the site. Details of the dam breach analysis are presented in DSRS Section 2.4.4 and will also be presented in the appropriate sections of applicant's FSAR.

The staff reviews the maximum water level at the site from the following causes:

- A. Failure of existing and proposed dam (or dams) or water storage tanks during safe shutdown earthquake (SSE) coincident with 25-year flood and 2-year wind waves.
- B. Failure of existing and proposed dam (or dams) or water storage tanks during operating basis earthquake (OBE) coincident with standard project flood (SPF) and 2-year wind waves. The OBE is defined by Appendix A to 10 CFR Part 100.

- C. Failure of existing and proposed dam (or dams) or water storage tanks during other earthquakes, coincident with runoff, surge, or seiche floods where the coincidence is at least as likely as for 2.A and 2.B above.
 - D. Breaches of existing and proposed water control structures that may be located above the site grade and sufficiently near SSCs important to safety.
 - E. Failure of ice and glacial dams in cold, mountainous regions, coincident with runoff, surge, or seiche floods where the coincidence is at least as likely as for 2.A and 2.B above.
3. Surges and Seiches. The staff reviews information related to flooding at the site from surge and seiches. The review considers simulated hurricane, simulated wind storm, resonance, wave runup and effects of sediment deposition and erosion in determining the design basis storm surge (DBSS) and seiches. Details of the surge and seiches analysis are presented in DSRS Section 2.4.5 will also be presented in the appropriate sections of the applicant's FSAR.
4. Tsunami. The staff reviews information related to flooding at the site from tsunami. The review considers historical tsunami data, tsunamigenic sources, tsunami propagation models, static and dynamic hydraulic forces, debris and water-borne projectiles in determining the design basis tsunami (DBT). Details of the tsunami analysis are presented in DSRS Section 2.4.6 and will also be presented in the appropriate sections of the applicant's FSAR.
5. Effects of Ice Formation in Water Bodies. The staff reviews information related to formation of ice sheet on surface of water bodies, frazil and anchor ice, and ice dam formation inasmuch as these phenomena may result in flooding, e.g., from backwater effects resulting from a downstream ice blockage or from a flood wave resulting from collapse of an upstream ice dam. The staff also reviews the potential for rupture of water storage tanks caused by freezing conditions that could result in a flood. Details of the ice induced flooding analysis are presented in DSRS Section 2.4.7 and will also be presented in the appropriate sections of applicant's FSAR.
6. Flooding Caused by Landslides and Channel Diversion. The staff reviews information related to flooding from landslide and backwater effects from stream blockage. The staff also reviews information related to flooding from channel diversion and channel migration. Hydrologic, geomorphological and other relevant historical data will be used in the review.

For sites in the permafrost region potential for channel migration as a result of thawing needs to be considered. Details of the channel diversion related flooding analysis are presented in DSRS Section 2.4.8 and will also be presented in the appropriate sections of the applicant's FSAR.

7. Combined Events Criteria. The staff summarizes the worst flooding at a site that may result from a reasonable combination of individual flooding phenomena. Some or all of these individual phenomena could be less severe than their worst-case occurrence but the combination may exceed the most severe flooding effects from the worst-case occurrence of any single phenomenon.

8. Consideration of Other Site-Related Evaluation Criteria. The staff considers the potential effects of seismic (including the effects of possible land subsidence) and non-seismic information on the postulated design bases and how they relate to floods in the vicinity of the site and the site region.
9. Additional Information for 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.

Flooding Protection Requirements

The staff reviews the locations and elevations of all SSCs important to safety to identify the SSCs exposed to flooding. The specific areas of review are as follows:

1. SSCs Important to Safety Exposed to Flooding or High Subsurface Hydraulic Head
2. Type of Flood Protection: The staff reviews the type of flood protection (e.g., “hardened facilities,” sandbags, flood doors, bulkheads, dewatering system, etc.) provided to those SSCs important to safety that are exposed to floods.
3. Emergency Procedures: The emergency procedures needed to implement flood protection activities and warning times available for their implementation are reviewed by the organization responsible for the review of issues related to plant emergency procedures. The technical specifications related to the emergency procedures needed to ensure adequate flood protection of the plant are reviewed by the organization responsible for the review of issues related to technical specifications.
4. 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 flooding protection for the proposed plant site are reviewed.
5. Additional Information for 10 CFR Part 52 Applications: Additional information will be presented depending 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.

Low Water Conditions

The staff reviews information related to low water conditions from a variety of causes. These include:

1. Low Water from Drought: To meet the requirements of GDC 2, GDC 44, 10 CFR Part 52.17, and 10 CFR Part 100, a complete history of low water conditions at and in the vicinity of the site is needed. A thorough listing of types of phenomena, locations and durations of these events, and descriptions of hydrometeorological characteristics accompanying these events should be included. These listings and descriptions should be sufficient to establish the history of droughts in the vicinity of the site. The staff will evaluate the applicant’s evidence as it relates to low water considerations. If the staff disagrees with the applicant’s conclusions, they will request

additional information. The applicant should fully document and justify its estimates or accept the staff's estimates and redesign safety-related SSC affected by low water levels. The suggested criteria of Regulatory Guide (RG) 1.27 apply when the water supply comprises part of the ultimate heat sink.

2. Low Water from Dam Breach: To meet the requirements of GDC 2, GDC 44, 10 CFR Part 52.17, and 10 CFR Part 100, low water conditions resulting from failure of existing and proposed dams and other water retaining structures both upstream and downstream of the site needs to be considered.
3. Low Water from Other Phenomena: To meet the requirements of GDC 2, GDC 44, 10 CFR Part 52.17, and 10 CFR Part 100, a complete history of low water conditions, caused by phenomena other than a drought, at and in the vicinity of the site is needed. A thorough listing of types of phenomena, locations and durations of these events, and descriptions of hydrometeorological and hydrogeological characteristics accompanying these events should be included. These listings and descriptions should be sufficient to establish the most severe low water event due to these phenomena reasonably possible in the vicinity of the site. These estimates of low water events caused by other phenomena should be consistent with the estimates in the respective FSAR sections where review of these individual phenomena is carried out. In case of disagreement between the staff's and the applicant's conclusions, the applicant should fully document and justify its conclusions or accept the staff's conclusions and redesign any safety-related SSC that may be affected by low water events.
4. Effect of Low Water on Safety-Related Water Supply: To meet the requirements of GDC 2, GDC 44, 10 CFR Part 52.17, and 10 CFR Part 100, a thorough description of all safety-related water supply requirements and the effects of the most severe low water event reasonably possible at or in the vicinity of the site is needed. The staff will review the proposed requirements of the plant with respect to the available water during the most severe low water event to assess the reliability of the proposed safety-related water supply. In case of disagreement between the staff's and the applicant's conclusions, the applicant should fully document and justify its conclusions or accept the staff's conclusions and redesign the safety-related water supply.
5. Water Use Limits: To meet the requirements of GDC 2, GDC 44, 10 CFR Part 52.17, and 10 CFR Part 100, a thorough description of water use and discharge limitations (both physical and legal), already in effect or under discussion by responsible Federal, regional, State, or local authorities, that may affect water supply at the plant that have been considered and are substantiated by reference to reports of the appropriate agencies is needed. The staff will review these water uses and use limitations to determine the reliability of the proposed safety-related water supply to the plant. In case of disagreement between the staff's and the applicant's conclusions, the applicant should fully document and justify its conclusions or accept the staff's conclusions and redesign the safety-related water supply.
6. Consideration of Other Site-Related Evaluation Criteria: To meet the requirements of GDC 2, 10 CFR Part 52.17, and 10 CFR Part 100, the applicant should provide an assessment of the potential effects of site-related proximity, seismic, and non-seismic information on the postulated worst-case low-flow scenario for the proposed plant site. This assessment should be sufficient to demonstrate that the applicant's design bases appropriately account for these effects.

Groundwater and Accidental Release of Radioactive Liquid Effluents

The staff reviews information related to groundwater as it relates to local and regional groundwater conditions and post-construction groundwater levels at the site. Impacts of hydrostatic loading at the site and its impact on SSCs important to safety will also be considered. The use of groundwater at the site will also be reviewed to determine whether SSCs important to safety will be impacted by availability of groundwater. Accidental release of radioactive liquid effluents will also be reviewed to determine transport pathways and concentrations at selected potable water sources. For sites to be located in the permafrost region impacts of freezing and thawing on groundwater flow and pathways needs to be considered.

1. Local and Regional Groundwater Characteristics and Use: The staff reviews identification of the aquifers, types of onsite groundwater use, sources of recharge, present withdrawals and known and likely future withdrawals, flow rates, travel time, gradients, and other properties that affect movement of accidental contaminants in groundwater, groundwater levels beneath the site, seasonal and climatic fluctuations, monitoring and protection requirements, and man-made changes that have the potential to cause long-term changes in local groundwater regime.
2. Effects on Plant Foundations and other Safety-Related SSCs: The staff reviews effects of groundwater levels and other hydrodynamic effects of groundwater on design bases of plant foundations and those of other safety-related SSC.
3. Reliability of Groundwater Resources and Systems Used for Safety-Related Purposes: The staff reviews reliability of groundwater resources and related systems used to supply safety-related water to the plant.
4. Reliability of Dewatering Systems: The staff reviews reliability of dewatering systems to maintain groundwater conditions within the plant's design bases.
5. Consideration of Other Site-Related Evaluation Criteria: The staff reviews potential effects of seismic and non-seismic information on the postulated worst-case groundwater conditions for the proposed plant site.
6. Alternate Conceptual Models: The staff reviews alternate conceptual models of the hydrology at the site that reasonably bound hydrogeological conditions at the site inasmuch as these conditions affect transport of radioactive liquid effluent in the ground and surface water environment.
7. Pathways: The staff reviews the bounding set of plausible surface and subsurface pathways from potential points of accidental release to determine the critical pathways that may result in the most severe impact on existing uses and known and likely future uses of ground and surface water resources in the vicinity of the site.
8. Characteristics that Affect Transport: The staff reviews the ability of ground and surface water environment with respect to their ability to delay, disperse, dilute, or concentrate accidentally released radioactive liquid effluent during its transport.

9. Consideration of Other Site-Related Evaluation Criteria: The staff reviews potential effects of seismic and non-seismic information on the postulated worst-case transport scenario of accidental releases of radioactive liquid effluents in ground and surface waters for the proposed plant site.
10. Additional Information for 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.

Permafrost Hydrology

Permafrost hydrology is of special interest because of the unique hydrologic, geologic, geochemical and climatic patterns that prevail in permafrost regions. Current research also indicates that the permafrost region is undergoing environmental changes characterized by accelerated thawing. Permafrost is defined as land and subsurface soil that remains below the freezing point of water for two or more consecutive years. In addition to accelerated thawing which results in changes in water pathways, land subsidence and formation of cracks, environmental changes in the permafrost region are also characterized by biogeochemical processes that result in release of gas hydrates¹.

Review areas will include information on the following:

1. Description of the hydrologic processes in the permafrost region: The staff reviews information on the major hydrologic processes that govern the hydrologic processes at the site.
2. Presence and extent of thawing at the site and in the vicinity of the site: The staff reviews information related to evidence of thawing and its extent as presented in regional data obtained from a variety of sources.
3. Presence of gas hydrates at the site and in the vicinity of the site: The staff reviews information related to the prevalence of gas hydrates at the site and in the vicinity of the site and their role in the local hydrologic processes. The review will also include the ability of gas hydrates to impact safe operation of SSCs important to safety.
4. Thermal gradient in the subsurface at the site and in the vicinity of the site: The staff reviews information related to the subsurface thermal gradient and its impact on site hydrologic processes and safe operation of SSCs important to safety.

III. REVIEW INTERFACES

This section is a summary of the information that will be reviewed in the various subsections of DSRS Chapter 2.4. These sections include the following:

1. 2.4.1 - Hydrologic Description
2. 2.4.2 - Floods and Site Drainage

¹ As and when it becomes available additional guidance on permafrost hydrology is to be used

3. 2.4.3 - Probable Maximum Floods
4. 2.4.4 - Potential Dam Failures
5. 2.4.5 - Surge and Seiche Flooding
6. 2.4.6 - Tsunami Hazards
7. 2.4.7 - Ice Effects
8. 2.4.8 - Cooling Water Canals and Reservoirs
9. 2.4.9 - Channel Diversions
10. 2.4.10 - Flooding Protection Requirements
11. 2.4.11 - Low Water Considerations
12. 2.4.12 - Groundwater
13. 2.4.13 - Accidental release of radioactive Liquid Effluents
14. 2.4.14 - Technical Specifications and Emergency Operation Requirements

IV. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria for DSRS Section 2.4 are based on meeting the relevant requirements of the NRC regulations presented below and satisfying the acceptance criteria of DSRS Sections 2.4.1 through 2.4.14 as appropriate. These sections are presented in the "REVIEW INTERFACES" of DSRS Section 2.4.0 and the information presented in this DSRS is derived from these sections.

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).
2. 10 CFR Part 50, Appendix A, GDC 2 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.
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.

4. 10 CFR Part 52.79(a)(31), for COL applications, as it relates to the effect of construction activities (including hydrologic modifications of the site) on SSCs important to safety of operating units at multi-unit sites.

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.

Appropriate sections of the following regulatory guides (RG) are used by the staff for the identified acceptance criteria:

- RG 1.27 describes the applicable ultimate heat sink capabilities.
- RG 1.29 identifies seismic design bases for SSCs important to safety.
- RG 1.59, as supplemented by best current practices, provides guidance for developing the flood design bases².
- RG 1.102 describes acceptable flood protection to prevent the SSCs important to safety from being adversely affected.
- RG 1.113, as supplemented by best current practices, provides guidance on evaluating the effect of the dispersion of accidental releases on resulting concentrations of radionuclides in surface water.

V. 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 hydrologic site characteristics 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.

² RG 1.59 is currently being updated and a new revision is expected by the end of 2013.

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 Safety Evaluation Report (SER) section.
2. Interface of the Plant with the Hydrosphere: The staff reviews hydrologic and hydraulic characteristics of watersheds, streams, lakes (e.g., location, size, shape, drainage area), shore regions, the regional and local groundwater environments, and existing or proposed water control structures (located both upstream and downstream from the proposed site, including characteristics such as location, size, capacity, type, seismic design criteria, and operational details). The staff will review the description of the plant's interface with the hydrosphere, to ascertain that it supports the development of alternative conceptual models of the hydrologic and geophysical phenomena that could affect the safety of the plant.

The review procedure consists of evaluating the completeness of the information and data by sequential comparison with information available from references. An important facet of the review procedure for this and other DSRS sections in hydrologic areas is the site visit. The site visit provides the technical reviewers with independent confirmation of hydrologic characteristics of the site and adjacent environs. The site visit is discussed in Appendix A to this DSRS section. A site audit may also be scheduled during the site visit to support the staff's review through detailed discussions with the applicant regarding the applicant's data, methods, and conclusions with the applicant.

3. Hydrologic and Geophysical Phenomena: The staff reviews hydrologic and geophysical characteristics in the vicinity of the site and site regions to identify all feasible flooding mechanisms. (Subsequent sections of the DSRS review these phenomena with respect to specification of site characteristics related to flood water elevation or subsurface hydraulic head, as related to the design bases of SSCs important to safety.) Historical conditions can be ascertained using data available from the USGS and other government agencies. The description and elevations of structures and facilities important to safety and accesses thereto should be sufficiently complete to allow evaluation of the effect of flood design bases in their respective sections.

The staff reviews historical hydrometeorological data to determine the hydrologic characteristics of the site regions. Streamflow data for rivers and streams in the vicinity of the site may be obtained from the U.S. Geological Survey (USGS). Meteorological data included in the FSAR may be obtained from National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center, Regional Climate Centers, or State Climate Offices. The U.S. Army Corps of Engineers (USACE) Cold Regions Research and Engineering Laboratory holds accumulated freezing degree-days data that is sufficient to evaluate icing on lakes and storage reservoirs. Historical data related to hurricanes, storm surges, seiches, and tsunamis, collected and maintained by NOAA, are also used in the staff's review of the plausible hydrologic and geophysical

phenomena. The USGS and state and local agencies may have relevant local information on groundwater levels and quality, and on hydrogeological conditions that affect them.

4. Surface and Groundwater Uses: The staff reviews data on surface and groundwater users, location with respect to the site, type of use, and quantity of water used to review the availability and reliability of water supply important to safety of the plant. Inventories of current and likely future water users, consistent with regional hydrologic inventories reported by applicable State and Federal agencies, are used in the staff's evaluation. The staff also reviews available projections of future water use, and if necessary of related projections of factors influencing water use, such as population.
5. Data: The staff reviews the identification and description of all spatial and temporal data that are used in the review of subsequent DSRS sections. Spatial data may be presented in a GIS format with a description of the computer software used to create the GIS layers. Temporal data may be presented electronically along with a description of the data format. The staff anticipates the use of the following data in the review of FSAR Section 2.4:
 - A. Spatially referenced data
 - i. Topographic and bathymetric data including elevation contours
 - ii. Location coordinates of the center of the powerblock and plant perimeter envelope
 - iii. Locations of streamflow gauges
 - iv. Locations of meteorological stations
 - v. Locations of water control structures including dams and reservoirs
 - vi. Locations of onsite or immediately adjacent water control, storage, or conveyance structures such as canals, dikes, levees, etc.
 - vii. Locations of surface and groundwater users
 - viii. Maps of soil types and subsurface characteristics identifying aquifers and confining units, and groundwater pathways
 - ix. Detailed topographic and bathymetric maps of the site area
 - x. Aerial photographs
 - xi. Geologic maps
 - xii. Locations of monitoring and pumping wells
 - xiii. Locations of springs and seeps

B. Temporal data

- i. Observed streamflow records near the site, both upstream and downstream
- ii. Observed streamflow records in neighboring basins if only limited streamflow data are available for the basin where the site is located
- iii. Observed groundwater level records and subsurface hydraulic heads at the reactor site and vicinity
- iv. Observed meteorological (air temperature, dew point, and rainfall) records near the site
- v. Historical records of hurricanes, surges, seiches, and tsunamis
- vi. Any relevant prehistorical records, e.g., paleo-tsunami evidence
- vii. Lake-water surface elevation and downstream discharge, if applicable
- viii. Historical records of sedimentation, littoral drift, hillslope failure, ice jams, ice-sheet formation on water bodies, channel diversions, etc., where applicable
- ix. Observed records of groundwater chemistry

6. Alternative Conceptual Models: The staff reviews a variety of alternative conceptual models of hydrologic and geophysical phenomena that are relevant for the site. These conceptual models need to be envisioned as part of the complete understanding of the surface and subsurface water movement. The conceptual model that presents the most adverse case of contaminant transport should be used to derive a conservative bounding estimate of travel time. Consideration should be given to surface and groundwater pathways, preferential flow in the subsurface, chemistry of the subsurface media, and other relevant physiographic, hydrologic, and hydrogeologic conditions to evaluate the most severe effect on people and the environment.

7. Consideration of Other Site-Related Evaluation Criteria: The staff reviews the applicant's assertions regarding the potential effects of site-related proximity and of seismic and non-seismic information (including the effects of possible land subsidence and effects on groundwater levels) as they relate to the hydrologic description of the vicinity of the proposed plant site and site regions to be assured that the applicant's design bases appropriately account for these effects.

Subpart B of 10 CFR Part 100 describes site-related proximity, seismic, and non-seismic evaluation criteria for power reactor applications. The staff's review will include evaluation of pertinent information to determine if these criteria are appropriately used in the hydrologic description of the proposed plant site.

8. Review Procedures Specific to 10 CFR Part 52 Applications

- A. ESP Reviews: Subpart A to 10 CFR Part 52 specifies the requirements and procedures applicable to the NRC'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 DC 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 Part 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 DSRS 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 sufficient information was 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 provided 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 since the issuance of the ESP 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.

VI. EVALUATION FINDINGS

The review should document the staff's evaluation of site characteristics with regard to 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 should never copy text provided by the applicant except in a direct quotation that is properly attributed.

In the case of COL reviews, the reviewer states their assessment of the design basis flood (DBF) and the maximum groundwater level with respect to the regulatory requirements and the Design Control Document (DCD) parameter values for the specific reactor types. The radioactive liquid effluent transport analysis results will also be verified against the applicable regulatory requirements.

For ESP reviews the reviewer states that the plant parameter envelopes identified are the site characteristic values and consistent with the design basis flood and maximum ground water level estimates for the site.

In the case of DCD reviews the reviewer confirms the suitability of the plant parameters identified in the document to ensure that they are applicable for sites within the United States.

VII. 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 Accession (ADAMS) 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 Standard Review Plan (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.

VIII. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."
2. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."
- D. 10 CFR Part 100, "Reactor Site Criteria."
3. ANSI/ANS-2.8-1992, "Determining Design Basis Flooding at Power Reactor Sites." Historical Technical Reference.

4. "Engineering and Design - Ice Engineering," EM 1110-2-1612, U.S. Army Corps of Engineers, Washington, DC, 2002 or later edition.
5. Final Interim Staff Guidance ESP/DC/COL-ISG-015, "Post-Combined License Commitments." January 21, 2010. Accession Number: ML093561416.
6. RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants."
7. RG 1.29, "Seismic Design Classification."
8. RG 1.59, "Flood Design Basis for Nuclear Power Plants."
9. RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)."
10. RG 1.102, "Flood Protection for Nuclear Power Plants."
11. RG 1.206, "Combined License Applications for Nuclear Power Plants. (LWR Edition)."
12. RG 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I."