



U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN**2.4.2 FLOODS****REVIEW RESPONSIBILITIES**

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

Secondary - None

I. AREAS OF REVIEW

Chapter 2 of the Standard Review Plan (SRP) discusses the site characteristics that could affect the safe design and siting of the plant. The staff reviews information presented by the applicant for a construction permit (CP), operating license (OL), design certification (DC), early site permit (ESP), or combined license (COL) concerning hydrological setting of the site as it relates to safety-related structures, systems, and components (SSC). This SRP section applies to reviews performed for each of these types of applications. The staff's review and findings are described in the appropriate section of the safety evaluation report (SER).

This section of the safety analysis report (SAR) identifies historical flooding (defined as occurrences of abnormally high water stage or overflow from a stream, floodway, lake, or coastal area) at the proposed site or in the region of the site. It summarizes and identifies the individual types of flood-producing phenomena, and combinations of flood-producing phenomena, considered in establishing the flood design bases for safety-related plant features. It also covers the potential effects of local intense precipitation. Although topical information

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USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in the Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of the standard format have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) will be based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)," until the SRP itself is updated.

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov.

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may appear in SAR Sections 2.4.3 through 2.4.7 and Section 2.4.9, the types of events considered and the controlling event are reviewed in this section.

The flood history and the potential for flooding are reviewed for the sources and events listed below. Factors affecting potential runoff (such as urbanization, forest fire, or change in agricultural use), erosion, and sediment deposition are considered in the review. In addition to describing flood history, this section of the SAR also determines the local intense precipitation on the site to estimate local flooding. Local intense precipitation is reported as a site characteristic used in site grading design. The review covers the following specific areas:

1. Local Flooding on the Site and Drainage Design
 - A. The staff reviews the flooding of the site produced by local intense precipitation. Local intense precipitation may be estimated from relevant National Oceanic and Atmospheric Administration (NOAA) hydrometeorological reports (HMR).
 - B. The staff reviews the design of the site drainage system, including grading to drain local intense precipitation away from safety-related SSC.
2. Stream Flooding
 - A. 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.
 - 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.
3. Surges
 - A. The staff reviews probable maximum hurricane (PMH) at coastal sites.
 - B. The staff reviews the PMH wind translated inland and resulting wave action coincident with runoff-induced flood levels.
 - C. The staff reviews probable maximum windstorm-induced (non-hurricane) storm surges and waves.
 - D. The staff reviews combinations of less severe surges, coincident with runoff floods.

4. Seiches

- A. The staff reviews meteorologically induced seiches in inland lakes (e.g., Great Lakes and harbors) and seiches at coastal harbors and embayments.
- B. The staff reviews seismically induced seiches in inland lakes.
- C. The staff reviews seismically induced seiches by tsunami (seismic sea waves) on coastal embayments.
- D. The staff reviews combinations of less severe surges and seiches, coincident with runoff floods.

5. Tsunami

- A. The staff reviews near field, or local, excitation that may induce a tsunami. It is also possible that a seismic event, with an epicenter located on land but near the coast, may generate a tsunami in an ocean. Propagation of such a tsunami may pose a safety hazard to the site.
- B. The staff reviews far field, or distant, excitation that may induce a tsunami that affects the plant site.
- C. The staff reviews hillslope failure-generated tsunami-like waves.
- D. The staff reviews submarine landslide-generated tsunami.
- E. The staff reviews inland tsunami: e.g., tsunami generated on the Mississippi River due to the February, 1812, New Madrid earthquake.

6. Seismically Induced Dam Failures (or Breaches)

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

- A. Failure of dam (or dams) during safe shutdown earthquake (SSE) coincident with 25-year flood and 2-year wind waves.
- B. Failure 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 during other earthquakes, coincident with runoff, surge, or seiche floods where the coincidence is at least as likely as for 6.A and 6.B above.
- D. Breaches of water control structures that may be located above the site grade and sufficiently near safety-related SSC.

7. Flooding Caused by Landslides

- A. The staff reviews flood waves.
- B. The staff reviews backwater effects due to stream blockage.

8. Effects of Ice Formation in Water Bodies

The staff reviews 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.

- 9. Combined Events Criteria: The staff reviews the worst flooding at a site that may result from a reasonable combination of individual flooding mechanisms. Some or all of these individual mechanisms 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 mechanism.
- 10. Consideration of Other Site-Related Evaluation Criteria: The staff considers the potential effects of seismic 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.
- 11. 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.

Review Interfaces

The listed SRP sections interface with this section as follows:

- 1. For DC applications and COL applications referencing a DC, review of the site parameters in the Design Control Document (DCD) Tier 1, Chapter 2 of the DCD Tier 2, and the supporting information in DCD Tier 2, Section 14.3, submitted by the applicant is performed under SRP Section 14.3.1, "Site Parameters (Tier 1)."
- 2. Sections 2.4.3 - 2.4.7, and Section 2.4.9 address specific flood-producing phenomena. The types of events considered in these sections and the controlling flooding event are described in this section.
- 3. Flooding protection measures, including dynamic effects (hydrodynamic forces and impact forces from debris and projectiles), if required for safety-related SSC, are described in Section 2.4.10.
- 4. The organization responsible for review of issues related to hydrology also reviews, under SRP Section 2.3.6 (proposed), the adequacy of the site parameter envelope specified in standard design certification applications.

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

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 hydrological features of the site. The requirements to consider physical site characteristics in site evaluations are specified in 10 CFR 100.10(c) for applications before January 10, 1997, and 10 CFR 100.20(c) for applications on or after January 10, 1997.
2. 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 2, for CP and OL applications, 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)(vi), for ESP applications, and 10 CFR 52.79 (a)(1)(iii), for COL applications, as they relates 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.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for review described in Subsection I of this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

Appropriate sections of the following Regulatory Guides are used by the staff for the identified acceptance criteria:

Regulatory Guide 1.27 describes the applicable ultimate heat sink capabilities.

Regulatory Guide 1.29 identifies seismic design bases for safety-related SSC.

Regulatory Guide 1.59, as supplemented by best current practices, provides guidance for developing the hydrometeorological design bases.

Regulatory Guide 1.102 describes acceptable flood protection to prevent the safety-related facilities from being adversely affected.

1. Local Flooding on the Site and Drainage Design: The application should include an estimate of local intense precipitation or local probable maximum precipitation (PMP) and a determination of the capacity of site drainage facilities (including drainage from the roofs of buildings and site ponding). Conclusions relating to the potential for any adverse effects of blockage of site drainage facilities by debris, ice, or snow should be based upon conservative assumptions of storm and vegetation conditions likely to exist during storm periods. If a potential hazard does exist (e.g., the elevation of ponding exceeds the elevation of plant access openings), the applicant should document and justify the design bases of affected facilities.
2. Stream Flooding: The application should include documentation of the potential sources of flood and flood response characteristics. Depending on the hydrology in the watershed where the proposed site is located, estimates of tributary contributing area, PMF, coincident wind-induced waves, floods produced due to dam failures, and combinations of less severe river floods with coincident surges and seiches should be provided.
3. Surges: The application should include the complete history of storm surges in the vicinity of the site. Depending on the location of the proposed site, estimates of PMH for coastal areas, PMH winds translated to inland locations, probable maximum windstorm, storm surges and waves resulting from these winds, and combinations of less severe storm surges with runoff floods should be provided.
4. Seiches: The application should include the complete history of seiches in the vicinity of the site. Depending on the location of the proposed site and hydrologic and hydraulic characteristics of nearby water bodies, estimates of meteorologically induced seiches in inland lakes, coastal harbors, and embayments, seismically induced seiches in inland lakes, seiches induced by tsunamis, and a combination of less severe seiches coincident with runoff floods should be provided.
5. Tsunami: The application should include the complete history of tsunami in the vicinity of the site. Both near and far-field tsunamigenic sources should be considered. Shallow seismic sources that are located on land, but are near the coast may generate an oceanic tsunami and should be considered. Far-field sources that may generate a tsunami that can travel long distances to affect the proposed site should be considered. Hillslope failures and slides that are generated on land and impact a water body (also called sub-aerial slides) may generate tsunami-like waves and should be considered. Submarine landslides are also known to generate tsunamis and should be considered. Seismic events can also generate tsunamis in inland water bodies, e.g., the tsunami-like wave generated in the Mississippi River due to the February, 1812, New Madrid earthquake. The possibility of such events affecting an inland site should be investigated.
6. Seismically Induced Dam Failures (or Breaches): The application should include the flooding hazard at the plant site resulting from seismically induced dam failure upstream of the site location. A complete listing of all dams and other relevant water control structures upstream of the site that may pose a flooding hazard to the site should be

presented. The effects of dam failure induced flooding in plant design bases should be provided. The maximum water surface elevation should be provided from failure of one or multiple dams during the SSE coincident with a 25-year flood and 2-year wind waves, from failure of one or multiple dams during the OBE coincident with a SPF and 2-year wind waves, from failure of one or multiple dams during other earthquakes of lesser intensity coincident with runoff, surge, or seiche flooding, and from breaches of water control structures that may be located above the site grade and sufficiently near safety-related SSC.

7. Flooding Caused by Landslides: The application should include the flooding hazard at the plant site from flood waves induced by landslides and backwater effects due to stream blockage from landslides. A thorough review of historical landslides and potential for landslides including any historical flooding caused by them in the vicinity of the site and site regions should be presented. The effects of landslide-induced flooding in the plant design bases should be considered.
8. Effects of Ice Formation in Water Bodies: The application should include information concerning potential flooding at the plant site due to flood waves resulting from the collapse of an ice dam or backwater effects due to stream blockage due to an ice dam or an ice jam downstream of the plant site. A thorough review of historical ice formation in the vicinity of the site and site regions should be presented and its effects should be appropriately accounted for in plant design bases. A thorough review of the history of frazil and anchor ice and an estimate of the flooding effects of these phenomena on plant design bases should be provided.
9. Combined Events Criteria: The application should include information concerning design basis flooding at the plant site, including consideration of appropriate combinations of individual flooding mechanisms in addition to the most severe effects from individual mechanisms themselves. The highest flood water surface elevation should be determined based on consideration of the worst combination of flooding mechanisms and is reported as a site characteristic in the staff's SER.
10. Consideration of Other Site-Related Evaluation Criteria: The application should demonstrate that the potential effects of site-related proximity, seismic, and non-seismic information as they relate to hydrologic description in the vicinity of the proposed plant site and site regions are appropriately taken into account.

Technical Rationale

The technical rationale for application of these requirements and/or SRP acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. Pursuant to GDC 2, nuclear power plant SSC important to safety 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 SSC shall reflect the following:
 - A. Appropriate consideration of the most severe natural phenomena historically reported for the site and 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 the effects 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 (e.g., floods) on the North American continent and, when based on probabilistic considerations only, the potential for underestimating the severity of such events. 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 that contribute to the severity of a given event.

This criterion is relevant to SRP Section 2.4.2 in that it specifies the hydrological phenomenon (i.e., flooding) addressed in this section. In general terms, it also specifies the level of conservatism that should be used to assess the severity of the flood for the purpose of determining the design bases for the SSC important to safety. This is a similar standard as that applied in reviewing ESPs or COLs.

Meeting the requirements of this criterion provides a level of assurance that SSC important to safety have been designed to withstand the most severe flood likely to occur.

- 2. Sections 100.10(c) and 100.20(c) of 10 CFR Part 100 requires that the site's physical characteristics (including seismology, meteorology, geology, and hydrology) be taken into account when determining its acceptability for a nuclear power reactor.

To satisfy the hydrological requirements of these sections, the applicant's SAR should contain a description of the surface and subsurface hydrological characteristics of the site and region and an analysis of the PMF. This description should be sufficient to assess the acceptability of the site and to assess the potential for those characteristics to influence the design of plant SSC important to safety.

Meeting this requirement provides a level of assurance that plant SSC important to safety are designed to withstand appropriately severe hydrological phenomena.

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from the procedures described below, as may be appropriate for a particular case.

The procedures outlined below are used to review CP applications, 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 SRP section. For reviews of OL applications, these procedures are used to verify that the data and analyses remain valid and that the facility's design specifications are consistent with these data. Reviews of OLs and COLs include a determination that the content of technical specifications related to

hydrology-related site characteristics are acceptable and consider any identified unique conditions.

For deviations from these specific acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives to the SRP criteria provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II of this SRP section.

1. **Local Flooding on the Site and Drainage Design:** Local intense precipitation is a measure of the extreme amount of water falling in the immediate vicinity of the site, usually taken as the one-square-mile PMP. In response to local intense precipitation, immediate flooding by ponding at the site may occur due to inadequate infiltration capacity and a lack of an efficient drainage system. The staff's estimates of flooding potential are based on PMP estimates from the appropriate HMRs published by NOAA. The staff's estimates are compared with the applicant's estimates to determine conformity to acceptance criteria in Subsection II of this SRP section. The local intense precipitation is reported as a site characteristic in the staff's SER.

Runoff models, such as the unit hydrograph if applicable, or other runoff discharge estimates presented in standard texts, are used to estimate discharge on the site drainage system under local intense precipitation. Where generalized runoff models are used, coefficients used for the site and region are compared to information available at documented locations to evaluate hydrological conditions used in determining the probable maximum flood for the site drainage system.

Protection from flooding caused by local intense precipitation cannot be mitigated by siting changes. Flooding from local intense precipitation should be mitigated by an effective and efficient site drainage system. The staff reviews site drainage design and any appropriate flooding protection required for safety-related SSC in this section of the SER. Flooding protection requirements are described in detail in SER Section 2.4.10.

2. **Stream Flooding:** The staff reviews the complete history of flooding in rivers and streams near the site. The staff's review uses historical records of streamflow (from the United States Geological Survey (USGS) or the U.S. Army Corps of Engineers (USACE)) and accompanying hydrometeorological conditions to evaluate flood-generation mechanisms that are relevant for the site safety review.

In order to establish the design-basis flood water elevation, the staff evaluates several severe flooding scenarios, which may include: (a) PMF coincident with upstream dam-failure (single or multiple failures including cascading failures due to hydrological causes) and wind-induced waves, (b) flooding due to backwater effects of downstream ice jams or collapse of an upstream ice dam, both independently and coincident with a winter probable maximum flood, and (c) a combination of less severe floods in streams combined with flooding effects of surges, seiches, and tsunamis, when applicable at a site. Individual flood-causing mechanisms are reviewed in SER Sections 2.4.3 through 2.4.7 and Section 2.4.9, as described in the corresponding SRP sections.

3. **Surges:** The staff reviews historical storm surge data and accompanying hydrometeorological conditions obtained from NOAA to evaluate flooding potential from storm surges at the site. In order to establish the design-basis flood water elevation, the staff evaluates the PMH and associated storm surge at coastal sites, wind-waves

caused by PMH winds translated to inland sites, and combination of less severe storm surges with runoff-induced floods. A detailed review of surge mechanisms and estimation of design-basis events is carried out in SER Section 2.4.5.

4. Seiches: The staff reviews historical data from USGS and NOAA to evaluate the potential effect of seiche activity in the vicinity of the site. In order to establish the design-basis flood water elevation, the staff evaluates and estimates the most severe seiche activity caused by atmospheric and seismic forcing. Less severe seiche activity may be combined with runoff-induced floods and storm surges to evaluate the design-basis flood elevation. A detailed review of seiche mechanisms and estimation of flood water elevation due to seiche activity is performed in SER Section 2.4.5.

5. Tsunami: The staff reviews historical data from USGS and NOAA to evaluate the potential effects of flooding due to tsunami at the site. Both near and far-field sources including seismic and submarine landslides are reviewed for coastal sites. Hillslope failure and sub-aerial landslide-generated tsunami-like waves are also reviewed if applicable for the site.

In order to establish design-basis flood water elevation, the staff evaluates and estimates flooding from a probable maximum tsunami. A detailed review procedure for review of tsunami hazards is described in SRP Section 2.4.6 and is carried out by the staff in SER Section 2.4.6.

6. Seismically Induced Dam Failures (or Breaches): The staff reviews historical data from USGS, USACE, and the Bureau of Reclamation to evaluate potential flooding at the plant site due to seismically induced dam failures. Flooding at the site could result from single or multiple dam failures, including cascading dam failures. Breaches of water control structures that may be located above the site grade and sufficiently near safety-related SSC is also evaluated for their potential effects on flooding at the plant site. A detailed review of flooding due to dam failures is described in SRP Section 2.4.4 and is carried out by the staff in SER Section 2.4.4.

7. Flooding Caused by Landslides: The staff reviews historical data from USGS, USACE, and other local, State, and Federal agencies and entities to evaluate potential flooding at the plant site due to flood waves caused by landslides and due to the backwater effects from a downstream blockage after a landslide. The review of flood waves generated by landslides is described in detail in SRP Section 2.4.6. The review of channel diversion, stream blocking, and backwater effects leading to flooding is described in SRP Section 2.4.9. A detailed staff review is carried out in SER Sections 2.4.6 and 2.4.9, respectively.

8. Effects of Ice Formation in Water Bodies: The staff reviews historical data from USGS, USACE, and CRREL to evaluate potential flooding at the plant site due to collapse of an upstream ice dam or backwater effects from a downstream ice jam. Review of ice formation is described in SRP Section 2.4.7 and that of stream blockage from ice dams and ice jams is described in SRP Section 2.4.9. A detailed staff review is carried out in SER Sections 2.4.7 and 2.4.9, respectively.

9. Combined Events Criteria: The staff reviews the combinations of individual flooding mechanisms that are reasonably possible. It is possible that a combination of two or

more flooding mechanisms that individually result in floods less severe than their respective worst-case occurrences may combine due to dependence among themselves and result in a more severe flood than the worst case of any one of the mechanisms occurring in isolation. ANSI/ANS-2.8-1992 provides guidance for determination of appropriate combinations of flooding mechanisms along with their relative severity within the combined events.

The staff uses the recommendations of ANSI/ANS-2.8-1992, supplemented with best current practices, to review the applicant's submittal in order to ensure that the most severe flood at the plant site has been determined. The highest flood water surface elevation is reported as a site characteristic in the staff's SER. The staff accepts the applicant's estimate of the highest water surface elevation if it is no more than 5% less conservative¹ than the corresponding staff's assessment.

All safety-related SSC should be protected against flooding by siting them above the highest flood water surface elevation or providing adequate flooding protection. Details of flooding protection measures are reviewed in SER Section 2.4.10.

10. Consideration of Other Site-Related Evaluation Criteria: The staff reviews the potential effects of site-related proximity, seismic, and non-seismic information as they relate to floods in the vicinity of the proposed plant site and site regions and verifies that plant design bases appropriately account for these effects.

10 CFR Part 100 describes site-related proximity, seismic, and non-seismic evaluation criteria for power reactor applications. Subpart A to 10 CFR Part 100 addresses the requirements for applications before January 10, 1997 and Subpart B is for applications on or after January 10, 1997. The staff's review will include evaluation of pertinent information to determine if these criteria are appropriately used in postulation of worst-case flooding scenario at the proposed plant site. The effects of these criteria on individual flooding mechanisms are review in the respective SRP sections.

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

- A. Early Site Permit 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 of review of data parallel that used for a CP review.

(1) The staff may accept site characteristics values presented in the SAR if that value is no more than 5% less conservative than the staff's independent estimate. For absolute values, e.g., accumulated freezing degree-days and local intense precipitation rates, the value itself will be used as the baseline. For relative measures, e.g., elevations measured above a datum, the location of the datum has a significant effect on the difference expressed as a percentage. The staff will use the site grade as the datum for elevation-based site characteristics. The above rule will only be applied to compare final values of site characteristics and will not be used to assess agreement with parameters or results of intermediate calculations.

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 on 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 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 should be representative of a reasonable number of sites that may be considered within a COL application;
 - ii. The appropriate site parameters are included as Tier 1 information per SRP Section 14.3.1; and
 - iii. Pertinent parameters are stated in a site-parameters summary table.
- C. Combined License 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, the 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 SRP section. Should the design of the facility not fall within the site characteristics and design parameters, the application should include a request for a variance from the ESP that complies with the requirements of 10 CFR 52.39 and 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. The requirements of 10 CFR Part 52.39 preclude the Commission from changing or imposing new site characteristics, design parameters, or terms and conditions on an ESP, unless the change is necessary to assure adequate protection of the public health and safety or to bring the permit or site into compliance with the Commission's regulatory requirements in effect when the permit was issued. Consequently, the staff's review of a COL application referencing an ESP should not include a re-investigation of the site characteristics that have previously been accepted in the referenced ESP. However, in accordance with 10 CFR Part 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 Part 52.39. Information provided by the applicant in accordance with 10 CFR Part 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 unresolved items, commitments, assumptions, and deferred issues identified in the FSERs are appropriately handled in the COL application.

IV. 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 submittal. The staff’s evaluation may include verification that the applicant followed applicable regulatory guidance, performance of independent calculations, and/or validation that the appropriate assumptions were made. 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 safety evaluation report. The reviewer also states the bases for those conclusions.

1. Construction Permit, Operating License, and Combined License Reviews

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

As set forth above, the applicant has presented and substantiated information relative to the local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism important to the design and siting of this plant. The staff has reviewed the available information provided and, for the reasons given above, concludes that the identification and consideration of the local intense precipitation and flooding at the site and in the surrounding area are acceptable and meet the requirements of [10 CFR Part 50, Appendix A, General Design Criterion 2, or 10 CFR 52.79, as applicable] and 10 CFR Part 100 [10 CFR Part 100.10(c) or 10 CFR Part 100.20(c), as applicable], with respect to determining the acceptability of the site.

The staff finds that the applicant has considered the appropriate site phenomena for establishing the site characteristics for SSCs important to safety. The staff has generally accepted the methodologies used to determine the local intense precipitation, flooding causal mechanisms, and controlling flooding mechanism reflected in these site characteristics, as documented in safety evaluation reports

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 design bases meet the requirement(s) of [10 CFR Part 50, Appendix A, General Design Criterion 2 or 10 CFR 52.79, as applicable] and 10 CFR 100.10(c) [or 10 CFR 100.20(c)], with respect to establishing the design basis for SSCs important to safety.

2. Early Site Permit Reviews

The following statements should be preceded by a summary of the site characteristics 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 local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism at the proposed site. Section 2.4.2, "Floods," of NUREG-0800, Standard Review Plan, provides that the site safety analysis report should address the requirements of 10 CFR Parts 52 and 100 as they relate to identifying and evaluating the local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism in the vicinity of the site and site regions. Further, the applicant considered the most severe natural phenomena that have been historically reported for the site and surrounding area and reasonable combination of these phenomena in establishing design-basis information pertaining to the local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism, 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 safety evaluation reports 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 or CP application.

Therefore, the staff concludes that the identification and consideration of the local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism set forth above are acceptable and meet the requirements of 10 CFR Part 52.17(a)(1)(vi), 10 CFR Part 100.20(c), and 10 CFR Part 100.21(d).

In view of the above, the staff finds the applicant's proposed site characteristics related to the local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism for inclusion in an ESP for the applicant's site, should one be issued, to be acceptable.

3. Design Certification Reviews

The following statement 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), but does not claim that they are representative of any particular percentile of possible sites in the United States, and does not assert the acceptability of the basis for the choice of values with respect to siting. The local intense precipitation, flooding causal mechanisms, and the controlling flooding mechanism 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.

For DC and COL reviews, the findings will also summarize (to the extent that the review is not discussed in other SER sections) the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable, and interface requirements and combined license action items relevant to this SRP section.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section, unless superceded by a later revision.

VI. REFERENCES²

1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."
2. 10 CFR Part 50, Appendix A, General Design Criterion 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." Historical Technical Reference.

(2) References for PMP estimates, time distribution, etc., are in SRP Section 2.4.3.

6. "Application of Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," Hydrometeorological Report No. 52, U.S. Department of Commerce National Oceanic and Atmospheric Administration and U.S. Department of Army Corps of Engineers, August 1982.
7. "Meteorological Criteria for Extreme Floods for Four Basins in the Tennessee and Cumberland River Watersheds," Hydrometeorological Report No. 47, U.S. Department of Commerce National Oceanic and Atmospheric Administration and Tennessee Valley Authority, May 1973.
8. "Meteorology of Important Rainstorms in the Colorado River and Great Basin Drainages," Hydrometeorological Report No. 50, U.S. Department of Commerce National Oceanic and Atmospheric Administration and U.S. Department of Army Corps of Engineers, December 1981.
9. "Probable Maximum Precipitation for California – Calculation Procedures," Hydrometeorological Report No. 58, U.S. Department of Commerce National Oceanic and Atmospheric Administration and U.S. Department of Army Corps of Engineers, October 1998.
10. "Probable Maximum Precipitation for California," Hydrometeorological Report No. 59, U.S. Department of Commerce National Oceanic and Atmospheric Administration and U.S. Department of Army Corps of Engineers, February 1999.
11. "Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages," Hydrometeorological Report No. 49, U.S. Department of Commerce National Oceanic and Atmospheric Administration and U.S. Department of Army Corps of Engineers, Reprinted 1984.
12. "Probable Maximum Precipitation – Pacific Northwest States, Columbia River (including portions of Canada), Snake River and Pacific Coastal Drainages," Hydrometeorological Report No. 57, U.S. Department of Commerce National Oceanic and Atmospheric Administration, U.S. Department of Interior Bureau of Reclamation, and U.S. Department of Army Corps of Engineers, October 1994.
13. "Probable Maximum Precipitation Estimates, - United States Between the Continental Divide and the 103rd Meridian," Hydrometeorological Report No. 55A, U.S. Department of Commerce National Oceanic and Atmospheric Administration, (U.S. Department of Army Corps of Engineers and U.S. Department of Interior Bureau of Reclamation), June 1988.
14. "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian," Hydrometeorological Report No. 51, U.S. Department of Commerce National Oceanic and Atmospheric Administration and U.S. Department of Army Corps of Engineers, June 1978.
15. "Probable Maximum Precipitation in the Hawaiian Islands," Hydrometeorological Report No. 39, U.S. Department of Commerce Weather Bureau, May 1963.

16. "Probable Maximum Precipitation and Snowmelt Criteria For Red River of the North Above Pembina, and Souris River Above Minot, North Dakota," Hydrometeorological Report No. 48, U.S. Department of Commerce National Oceanic and Atmospheric Administration and U.S. Department of Army Corps of Engineers, May 1973.
17. "Probable Maximum Precipitation and Snowmelt Criteria for Southeast Alaska," Hydrometeorological Report No. 54, U.S. Department of Commerce National Oceanic and Atmospheric Administration and U.S. Department of Army Corps of Engineers, September 1983.
18. "Probable Maximum and TVA Precipitation Estimates With Areal Distribution for Tennessee River Drainages Less Than 3,000 Mi² in Area," Hydrometeorological Report No. 56, U.S. Department of Commerce National Oceanic and Atmospheric Administration and Tennessee Valley Authority, October 1986.
19. Reports of Great Lakes levels by National Ocean Survey, National Oceanic and Atmospheric Administration.
20. Regulatory Guide 1.29, "Seismic Design Classification."
21. Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants." Historical Technical Reference.
22. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."
23. Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants."
24. Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants." (LWR Edition)
25. "Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates, - United States East of the 105th Meridian," Hydrometeorological Report No. 53, U.S. Department of Commerce National Oceanic and Atmospheric Administration and U.S. Nuclear Regulatory Commission NUREG/CR-1486, April 1980.
26. "Surface Water Supply of the United States,"³ U.S. Geological Survey.
27. "Tide Tables," National Oceanic and Atmospheric Administration (similar situation as identified in footnote 3).

(3) "Surface Water Supply" is a continuing series of water discharge measurements by the USGS and others. It is not practical to list all the volumes (called "Water-Supply Papers") that are not available. Numerous State and local authorities maintain river discharge, lake level, and tide data.

28. U.S. Army Corps of Engineers records maintained in District and Division Offices, Coastal Engineering Research Center, and Waterways Experiment Station.

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the draft Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

SRP Section 2.4.2

Description of Changes

This SRP section affirms the technical accuracy and adequacy of the guidance previously provided in Draft Revision 4, dated April 1996 of this SRP. See ADAMS accession number ML052070240.

In addition, this SRP section was administratively updated in accordance with NRR Office Instruction, LIC-200, Revision 1, "Standard Review Plan (SRP) Process." The revision also adds standard paragraphs to extend application of the updated SRP section to prospective submittals by applicants pursuant to 10 CFR Part 52.

The technical changes are incorporated in Revision 4, dated 2007:

Review Responsibilities - Reflects changes in review branches resulting from reorganization and branch consolidation. Change is reflected throughout the SRP.

I. AREAS OF REVIEW

1. Introductory text was added at the beginning of this section.
2. Added text to indicate that local intense precipitation is estimated and reported as a site characteristic in this section.
3. Added local flooding on the site in response to local intense precipitation as a new area of review.
4. Additions to the tsunami area of review include tsunamis caused by (a) a seismic event with its epicenter located on land but near the coast, (b) a hillslope failure, (c) a submarine landslide, and (d) a seismic event on inland water bodies.
5. Added breaches of onsite water control structures to expand the seismically-induced dam failures area of review.
6. Expanded effects of ice formation in water bodies area of review to include ice sheet formation on surface of water bodies, frazil and anchor ice, and ice dam and ice jam formation as they may affect flooding at the site.
7. Added review of combined events criteria as a new area of review.
8. Added consideration of seismic and non-seismic criteria on worst-case flooding scenario as required by 10 CFR Part 100.21.
9. Expanded Review Interfaces subsection to state that review of site parameters for DC applications and COL applications that reference a DC is performed in SRP Section 14.3.
10. Expanded Review Interfaces subsection to indicate interface of this section with Sections 2.4.3-2.4.7 and Section 2.4.9, where individual flooding mechanisms are reviewed.

11. Expanded Review Interfaces subsection to indicate interface with Section 2.4.10, where flooding protection requirements are reviewed, based on design-basis flooding scenario described in this section.

II. ACCEPTANCE CRITERIA

1. Acceptance Criteria section was updated to include requirements of 10 CFR Part 100 as it relates to site evaluations in 10 CFR 100.10(c) for applications before January 10, 1997, and 10 CFR 100.20(c) for applications on or after January 10, 1997, in Acceptance Criteria.
2. Acceptance Criteria section was updated to include currently available best practices to supplement recommendations of Regulatory Guide 1.59.
3. Specific acceptance criteria for each item in area of review was rewritten to realign with the Commission's regulations.

III. REVIEW PROCEDURES

1. Introductory paragraphs were added at the beginning of Review Procedures section to provide guidance related to application of the procedures described therein to different types of applications.
2. Review Procedures section was rewritten to provide specific guidance related to each area of review. Estimation of local intense precipitation based on current NOAA HMR, estimation of runoff on the site in response to local intense precipitation, and determination of flooding protection for safety-related SSC was added.
3. Added a definition of the "no more than 5% less conservative" rule.

IV. EVALUATION FINDINGS

1. This section was rewritten to provide specific guidance related to each type of application. Sample statements addressing evaluation findings for each application type were also rewritten.

V. IMPLEMENTATION

1. The Implementation section was revised to indicate that this SRP section will also be used in reviews of design certification applications.

VI. REFERENCES

1. The References list was updated.