



U.S. NUCLEAR REGULATORY COMMISSION  
**STANDARD REVIEW PLAN**  
OFFICE OF NUCLEAR REACTOR REGULATION

## 10.4.5 CIRCULATING WATER SYSTEM

### REVIEW RESPONSIBILITIES

Primary - ~~Auxiliary Systems Branch (ASB)~~ Plant Systems Branch (SPLB)<sup>1</sup>

Secondary - None

#### I. AREAS OF REVIEW

The circulating water system (CWS) provides a continuous supply of cooling water to the main condenser to remove the heat rejected by the turbine cycle and auxiliary systems.

1. The ~~ASB~~SPLB<sup>2</sup> reviews the performance of the CWS with respect to its functional requirements and the effects of adverse environmental occurrences, ~~abnormal operational transients~~ anticipated operational occurrences,<sup>3</sup> or accident conditions such as loss of offsite power.
2. The ~~ASB~~SPLB<sup>4</sup> reviews the CWS and its interfaces with other systems to determine that a malfunction, failure of a component, or failure of a circulating water pipe, including the failure of an expansion joint, do not have unacceptable adverse effects on the functional performance capabilities of safety-related systems located in the immediate area.
3. ~~ASB~~SPLB<sup>5</sup> further reviews the design of the circulating water system with respect to the following:
  - a. The capability to prevent or detect and control flooding of safety-related areas so that the intended safety function of a safety system or component will not be precluded due to circulating water system leakage.

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#### USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

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- b. Provisions to announce abnormal and unsafe operating conditions.

### Review Interfaces

The SPLB performs the following reviews as part of its primary review responsibility under the Standard Review Plan (SRP) sections indicated:<sup>6</sup>

4.<sup>7</sup>

1. ASBSPLB<sup>8</sup> also<sup>9</sup> performs the review of high- and moderate-energy pipe breaks under SRP Section 3.6.1. SRP Section 3.6.1 identifies the circulating water system as a moderate-energy system included in the scope of review.<sup>10</sup>
2. SPLB determines whether liquid-carrying systems could produce flooding and evaluates the measures taken to protect safety-related equipment from internal flooding under SRP Section 3.4.1.<sup>11</sup>

In addition, the ASBSPLB<sup>12</sup> will coordinate other branch evaluations that interface with the overall review of the CWS, as follows:

5<sup>13</sup> —

1. Upon request, ~~Chemical Engineering Branch (CEB)~~ Materials and Chemical Engineering Branch (EMCB)<sup>14</sup> will review the compatibility of the methods proposed for control of water chemistry and of long-term corrosion and organic fouling with system components and piping materials, and will ~~assure~~ ensure<sup>15</sup> that agents used for the control of water chemistry, corrosion, and organic fouling ~~should be~~ are<sup>16</sup> compatible with the materials of the system.
2. The Mechanical Engineering Branch (EMEB) reviews the classification of systems quality groups as part of its primary review responsibility for SRP Section 3.2.2.<sup>17</sup>
3. As part of its primary review responsibilities, the Instrumentation and ~~Control Systems~~ Controls Branch (ICSB)(HICB)<sup>18</sup> in SRP Sections 7.1 and 7.6 and the Power Systems Branch (PSB) in SRP Sections 8.3.1 and 8.3.2 reviews instrumentation and controls and electrical power systems<sup>19</sup> as they may relate to operations that could affect safety-related systems or components.
4. The Electrical Engineering Branch (EELB) reviews electrical power systems, as they may relate to operations that could affect safety-related systems or components, as part of its primary review responsibilities for SRP Sections 8.3.1 and 8.3.2.<sup>20</sup>
5. The Civil Engineering and Geosciences Branch (ECGB) reviews the potential for low water conditions (e.g., those associated with drought) that may affect the CWS design as part of its primary review responsibilities for SRP Section 2.4.11.<sup>21</sup>

For those areas of review identified above as being the responsibility of other branches, the acceptance criteria and their methods of application are contained in the SRP sections identified as the primary review responsibility of those branches.

## II. ACCEPTANCE CRITERIA

Acceptability of the circulating water system, as described in the applicant's safety analysis report (SAR), is based on meeting the requirements of General Design Criterion 4 (GDC 4), "Environmental and Dynamic Effects Design Bases,"<sup>22</sup> as it relates to design provisions provided to accommodate the effects of discharging water that may result from a failure of a component or piping in the CWS. Compliance with GDC 4 is based on meeting the following:

1. Means should be provided to prevent or detect and control flooding of safety-related areas so that the intended safety function of a system or component will not be precluded due to leakage from the CWS.
2. Malfunction or a failure of a component or piping of the CWS, including an expansion joint, should not have unacceptable adverse effects on the functional performance capabilities of safety-related systems or components.

### Technical Rationale

The technical rationale for application of these acceptance criteria to reviewing the circulating water system is discussed in the following paragraphs:<sup>23</sup>

GDC 4 requires that structures, systems, and components important to safety shall be designed to accommodate the effects and be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

Although the circulating water system is not safety related, GDC 4 establishes CWS design limits that will minimize the potential for creating adverse environmental conditions (e.g., flooding of systems and components important to safety).

Meeting the requirements of this criterion provides a level of assurance that systems and components important to safety will perform their intended safety functions.<sup>24</sup>

## III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) reviews to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report meet the acceptance criteria given in subsection II. For the review of operating license (OL) applications, the procedures are used to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report.

Upon request from the primary reviewer, the coordinating review branches will provide input for the areas of review stated in subsection I. The primary reviewer obtains and uses such input as required to ~~assure~~ ensure that this review procedure is complete.

The reviewer will select and emphasize material from this SRP section as may be appropriate for a particular case.

1. Although the circulating water system is not safety related, a failure of this system, or any of its components, may affect a safety-related component or system. Since large quantities of water flow through the CWS, a leak or break in a component or pipe or expansion joint failure could cause severe and unacceptable flooding of adjacent areas. The reviewer verifies that the design includes provisions to minimize hydraulic transients and their effect upon the functional capability and the integrity of system components.

In evaluating the effects of the failure of an expansion joint, ASBSPLB<sup>25</sup> assumes that the butterfly valve(s) are not available to isolate CWS flow out of the failed expansion joint unless the valve(s) have been designed to safety-grade requirements. The ASBSPLB<sup>26</sup> reviews the descriptions and drawings in the SAR and determines that provisions are incorporated in the design to prevent unacceptable flooding of areas containing safety-related equipment or to mitigate the consequences of flooding.

2. The ASBSPLB<sup>27</sup> reviews the CWS to verify that the capability to detect leaks and to secure the system quickly and effectively exists.<sup>28</sup>
3. Based on the information contained in the SAR, the reviewer verifies that the applicant's proposed methods for control of water chemistry and of long-term corrosion and organic fouling, and the chemical agents used for these purposes, are compatible with the system materials.

For standard design certification reviews under 10 CFR Part 52, the procedures above should be followed, as modified by the procedures in SRP Section 14.3 (proposed), to verify that the design set forth in the standard safety analysis report, including inspections, tests, analysis, and acceptance criteria (ITAAC), site interface requirements and combined license action items, meet the acceptance criteria given in subsection II. SRP Section 14.3 (proposed) contains procedures for the review of certified design material (CDM) for the standard design, including the site parameters, interface criteria, and ITAAC.<sup>29</sup>

#### IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and his that the<sup>30</sup> review supports conclusions of the following type, to be included in the staff's safety evaluation report:

The circulating water system includes all components and equipment necessary to provide the main condenser with a continuous supply of cooling water. The system is designed to nonnuclear safety, Quality Group D, requirements since it is not necessary for safe shutdown, accident prevention, or accident mitigation. Based on the review of the applicant's proposed design criteria and bases for the circulating water system, the staff concludes that the design of the circulating water system is acceptable and meets the requirements of General Design Criterion 4. This conclusion is based on the following:

The applicant has met the requirements of General Design Criterion 4 with respect to the effects of discharging water that may result from a failure of a component or piping in the CWS. Acceptance is based on provisions of the design that prevent flooding of safety-related areas so that the intended safety function of a system or component will not be precluded due to leakage from the CWS; or provisions of the design that detect and control flooding of safety-related areas so that the intended safety function of a system or component will not be precluded due to leakage from the CWS; or provisions of the design such that malfunction of a component or piping of the CWS, including an expansion joint, will not have unacceptable adverse effects on the functional performance capabilities of safety-related systems or components.

For design certification reviews, the findings will also summarize, to the extent that the review is not discussed in other safety evaluation report sections, the staff's evaluation of inspections, tests, analyses, and acceptance criteria (ITAAC), including design acceptance criteria (DAC), site interface requirements, and combined license action items that are relevant to this SRP section.<sup>31</sup>

## V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of license applications submitted by applicants pursuant to 10 CFR 50 or 10 CFR 52.<sup>32</sup> Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of 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.<sup>33</sup>

## VI. REFERENCES

1. 10 CFR Part 50, General Design Criterion 4, "Environmental and Missile Dynamic Effects"<sup>34</sup> Design Bases."

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**SRP Draft Section 10.4.5**  
Attachment A - Proposed Changes in Order of Occurrence

Item numbers in the following table correspond to superscript numbers in the redline/strikeout copy of the draft SRP section.

Item	Source	Description
1.	Current PRB name and abbreviation	Changed PRB to Plant Systems Branch (SPLB).
2.	Current PRB designation	Changed PRB to SPLB.
3.	Editorial modification (based on USI B-3)	Replaced "abnormal operational transients" with "anticipated operational occurrences."
4.	Current PRB designation	Changed PRB to SPLB.
5.	Current PRB designation	Changed PRB to SPLB.
6.	SRP-UDP format item	Added "Review Interfaces" and lead-in paragraph for PRB primary reviews of other SRP sections.
7.	Editorial modification	Deleted number 4. Sequence broken by identifying the following review areas as review interfaces.
8.	Current PRB designation	Changed PRB to SPLB.
9.	Editorial modification	Removed "also" as unnecessary and confusing.
10.	Editorial modification	Added a sentence to declare that the circulating water system is addressed under SRP Section 3.6.1. The review interface is not really defined because it does not state what is addressed under 3.6.1 and what is addressed under 10.4.5; neither plan is specific. SRP Section 3.6.1 does not reference SRP Section 10.4.5. EVALUATION FINDINGS in SRP Section 3.6.1 instructs the reviewer to find that the facility design for protection against postulated piping failures outside containment is acceptable and complies with GDC 4 with respect to accommodating the effects of postulated pipe ruptures. SRP Section 10.4.5 instructs the reviewer to make essentially the same finding.
11.	Editorial modification	Added a cross reference to the review of internal flooding done under SRP Section 3.4.1. The second paragraph of paragraph 1 under REVIEW PROCEDURES instructs the reviewer to determine that provisions are incorporated into the design to prevent or mitigate flooding. Without the cross reference, this review appears to duplicate the review under SRP Section 3.4.1.
12.	Current PRB designation	Changed PRB to SPLB.
13.	Editorial modification	Deleted number. Sequence is broken because the item is now in "Review Interfaces" rather than in AREAS OF REVIEW.
14.	Current review branch designation	Changed review interface branch to EMCB.

**SRP Draft Section 10.4.5**  
Attachment A - Proposed Changes in Order of Occurrence

Item	Source	Description
15.	Editorial modification	Changed "assure" to "ensure" (global change for this section).
16.	Editorial modification	Changed "should be compatible" to "are compatible" to strengthen the thought.
17.	Editorial modification	Added SRP Section 3.2.2 as a review interface because EVALUATION FINDINGS in Revision 2 directs the reviewer to conclude that the circulating water system is designed to nonnuclear safety, Quality Group D, requirements.
18.	Current review branch designation	Changed review interface branch to HICB.
19.	Editorial modification	Broke this sentence into paragraphs because two different review interface branches are involved.
20.	Editorial modification	The interface with the EELB was made a separate paragraph from the interface with the HICB. The EELB was identified as the Power Systems Branch in Revision 2 of SRP Section 10.4.5.
21.	Editorial modification	A review interface with SRP Section 2.4.11 is added because Regulatory Guide 1.70, paragraph 10.4.5, requires an applicant to provide references to paragraphs 2.4.11.5 and 2.4.11.6, where applicable.
22.	Editorial modification	Added initialism and title for GDC 4 to aid the reviewer. Note that the title of GDC 4 has changed since Revision 2 of the SRP section was issued (see REFERENCES).
23.	SRP-UDP format item	Added "Technical Rationale" and lead-in paragraph to ACCEPTANCE CRITERIA.
24.	SRP-UDP format item	Added technical rationale for GDC 4.
25.	Current PRB designation	Changed PRB to SPLB.
26.	Current PRB designation	Changed PRB to SPLB.
27.	Current PRB designation	Changed PRB to SPLB.
28.	Editorial modification	Deleted "that" and "exists" and added "to" for clarity.
29.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
30.	Editorial modification	Revised sentence to eliminate gender-specific pronoun ("his").
31.	SRP-UDP format item	Added standard paragraph at the end of EVALUATION FINDINGS to set forth additional findings for the design certification review.



**SRP Draft Section 10.4.5**  
Attachment A - Proposed Changes in Order of Occurrence

<b>Item</b>	<b>Source</b>	<b>Description</b>
32.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard sentence to address application of the SRP section to reviews of applications filed under 10 CFR Part 52, as well as Part 50.
33.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
34.	Editorial modification	Updated the title of GDC 4 as changed by rulemaking in 1987.

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**SRP Draft Section 10.4.5**  
Attachment B - Cross Reference of Integrated Impacts

<b>Integrated Impact No.</b>	<b>Issue</b>	<b>SRP Subsections Affected</b>
	No Integrated Impacts were incorporated in this SRP Section.	