



U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

10.4.6 CONDENSATE CLEANUP SYSTEM

REVIEW RESPONSIBILITIES

Primary - ~~Chemical Engineering Branch (CMEB)~~ Materials and Chemical Engineering Branch (EMCB)¹

Secondary - None

I. AREAS OF REVIEW

The condensate cleanup system (CCS) removes dissolved and suspended impurities due to corrosion from condenser or steam generator leaks that could be introduced into the CCS by carryover from the main steam system. The CCS is not required for safe shutdown or mitigation of postulated accidents, but is important in maintaining the primary coolant quality in ~~direct cycle plants~~ boiling water reactors (BWRs)² or and³ the secondary coolant quality in ~~indirect cycle plants~~ pressurized water reactors (PWRs).⁴

The ~~CMEB~~ EMCB⁵ reviews the CCS from the supply point downstream of the condensate pumps to the discharge point upstream of the feedwater heaters, and also to the interfaces with the effluent treatment systems.

- ~~1. The CMEB assures that the CCS is reviewed to verify that the system provides feedwater to the reactor for direct cycle plants or to steam generators for indirect cycle plants that meets water purity requirements. Condensers are reviewed to determine that proper design measures are taken to assure that the chloride concentration and other contaminant concentrations are limited to allowable values until the condensate and feedwater systems can be isolated in the event of condenser tube leaks.~~

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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.

2. ~~A review is performed by CMEB to determine that the quality of the water supplied to the reactor for direct cycle plants (SRP Section 5.4.8), and to the steam generators for indirect cycle plants (BTP MTEB 5-3), meets water purity requirements. CMEB reviews are performed to verify the compatibility of the materials of construction with the service conditions.~~

The review determines that the water supplied to the reactor for BWRs (Standard Review Plan (SRP) Section 5.4.8), and to steam generators for PWRs (Branch Technical Position (BTP) MTEB 5-3), meets purity requirements. Condensers are reviewed to determine that proper design measures are taken to ensure that, in the event of condenser tube leaks, concentrations of chloride and other contaminants can be limited to allowable values until the condensate and feedwater systems are isolated. The review verifies the compatibility of the materials of construction with service conditions.⁶

Review Interfaces:⁷

1. The EMCB performs the following reviews as part of its primary review responsibility under the SRP sections indicated:
 - a. For BWRs, EMCB reviews the compatibility of reactor water chemistry with reactor coolant pressure boundary materials as part of its primary review responsibility for SRP Section 5.2.3.
 - b. EMCB reviews reactor water chemistry and control programs applicable to the BWR reactor water cleanup system as part of its primary review responsibility for SRP Section 5.4.8.
 - c. EMCB reviews the compatibility of reactor water chemistry programs with PWR steam generator materials as part of its primary review responsibility for SRP Section 5.4.2.1.⁸
2. ~~CMEB~~EMCB⁹ will coordinate the evaluations of other branches that interface with the overall review of the condensate cleanup system, as follows:
 - a. The ~~Auxiliary Systems Branch (ASB)~~Plant Systems Branch (SPLB)¹⁰ reviews the system to determine that the design satisfies the recommendations of ~~Branch Technical Position BTP~~¹¹ ASB 3-1 with respect to breaks and cracks in high- and moderate-energy system piping as part of its primary review responsibility for SRP Section 3.6.1. Compliance with BTP ASB 3-1 ensures that a failure of CCS piping does not render other safety-related systems inoperable.¹²
 - b. The ~~Effluent Treatment Systems Branch (ETSB)~~SPLB¹³ determines the effect of the CCS on fission and corrosion product concentrations and the effect of the quantity of spent resin and regenerant solution on radwaste system requirements as part of its primary review responsibility for SRP Sections 11.2, 11.3, and 11.4.

- c. The shielding design for the condensate demineralizer system is reviewed by the ~~Radiological Assessment Branch~~ Emergency Preparedness and Radiation Protection Branch (PERB)¹⁴ as part of its primary review responsibility for SRP Section 12.2.
- d. The review for technical specifications is coordinated and performed by the ~~Licensing Guidance Branch~~ Technical Specifications Branch (TSB)¹⁵ as part of its primary review responsibility for SRP Section 16.0.

For those areas of review identified above as being reviewed as part of the primary review responsibility of other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branch.

II. ACCEPTANCE CRITERIA

~~EMEB~~ MCB¹⁶ acceptance criteria for the CCS is are¹⁷ based on meeting the relevant requirements of General Design Criterion 14 (GDC 14), "Reactor Coolant Pressure Boundary,"¹⁸ as it relates to the water chemistry control being capable of preventing adverse chemistry conditions that could degrade the primary coolant boundary integrity. Specific criteria necessary to meet requirements of GDC 14 are as follows:

1. For ~~direct cycle (BWR) plants~~ BWRs,¹⁹ the design of the CCS should conform to the recommendations of Regulatory Guide 1.56,²⁰ as related to the design of condensate demineralizer systems to maintain the proper water purity specified for the reactor.
2. For ~~indirect cycle (PWR) plants~~ PWRs,²¹ the secondary water chemistry program should conform with SRP Section 5.4.2.1, "Branch Technical Position MTEB 5-3."

Technical Rationale:

The technical rationale for application of these acceptance criteria to reviewing the condensate cleanup system is discussed in the following paragraphs:²²

GDC 14 requires that the reactor coolant pressure boundary shall be designed, fabricated, erected, and tested to ensure an extremely low probability of abnormal leakage, rapidly propagating failure, and gross rupture.

GDC 14 applies to SRP Section 10.4.6 because the condensate cleanup system maintains water quality to avoid corrosion-induced failure of the reactor pressure boundary. Regulatory Guide 1.56 and BTP MTEB 5-3 describe acceptable methodologies for maintaining purity levels in the reactor coolant for BWRs and PWRs, respectively.

Meeting the requirements of this criterion provides a level of assurance that deterioration of the reactor coolant pressure boundary will not occur as the result of deficiencies in water purity control.²³

III. REVIEW PROCEDURES

The review procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design as set forth in the preliminary safety analysis report (PSAR) meet the acceptance criteria given in subsection II of this SRP section. 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 (FSAR).

~~Upon request from~~EMCB²⁴ will provide input to the primary reviewers of those SRP sections listed above under Review Interfaces, as requested~~the CMEB will provide input for the areas of review stated in subsection I of this SRP section. The primary reviewer uses such input as required to assure that this review procedure is complete.~~²⁵

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

1. ~~CMEB~~EMCB²⁶ evaluates the system design information and drawings and, utilizing engineering judgment, operational experience, and performance characteristics of similar, previously approved systems, verifies that:

- a. The system meets the requirements for condensate cleanup capacity, provides effluent of the required purity, and contains adequate instrumentation to monitor the effectiveness of the system. For BWRs refer to Regulatory Guide 1.56, and for PWRs refer to BTP MTEB 5-3.

The reviewer should coordinate the review of SRP Section 10.4.6 with that of other SRP sections listed in Review Interfaces to ensure that water chemistry guidelines and standards adopted by the applicant are applied consistently for all affected systems.²⁷

If a BWR applicant proposes to use hydrogen water chemistry, the reviewer should ensure that the condensate cleanup system conforms with EPRI NP-4947-SR, "BWR Hydrogen Water Chemistry Guidelines."²⁸

- b. The system is connected to radioactive waste disposal systems to allow disposal of spent resin or regenerant solutions when required.
2. ~~ASBSPLB~~²⁹ reviews the effects of CCS high- and moderate-energy piping failures under SRP Section 3.6.1 to~~assure~~ ensure³⁰ that other safety-related systems are not rendered inoperable.
 3. ~~ETSBSPLB~~³¹ determines the capability to treat and process spent resin and resin regenerant solutions in liquid and solid waste management systems under SRP Sections 11.2, 11.3, and 11.4.

4. ~~RABPERB~~³² determines the adequacy of the shielding design of the condensate demineralizers under SRP Section 12.2.

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.³³

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided to support conclusions of the following type, to be included in the staff's safety evaluation report:

The condensate cleanup system includes all components and equipment necessary for the removal of dissolved and suspended impurities which may be present in the condensate. Based on the staff's review of the applicant's proposed design criteria and design bases for the condensate cleanup system and the requirements for operation of the system, the staff concludes that the design of the condensate cleanup system and supporting systems is acceptable and meets the primary boundary integrity requirements of General Design Criterion 14. This conclusion is based on the applicant having met the requirements of GDC 14 as it relates to maintaining acceptable chemistry control for BWR reactor coolant and for PWR secondary coolant during normal operation and anticipated operational occurrences by reducing corrosion of BWR reactor system components and of PWR steam generator tubes and materials, thereby reducing the likelihood and magnitude of reactor piping failures and of primary-to-secondary coolant leakage. This requirement has been met by the applicant's design of the CCS meeting the regulatory positions of Regulatory Guide 1.56 for BWRs and meeting the Branch Technical Position MTEB 5-3 for PWRs.

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.³⁴

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plan 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 52.³⁵ 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.³⁶

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 14, "Reactor Coolant Pressure Boundary."
2. Regulatory Guide 1.56, "Maintenance of Water Purity in Boiling Water Reactors."
3. Branch Technical Positions ASB 3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment," attached to SRP Section 3.6.1, "Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment."³⁷ and MEB 3-1, "~~Postulated Break and Leakage Locations in Fluid System Piping Outside Containment,~~" attached to SRP Section 3.6.2.³⁸
4. Branch Technical Position MTEB 5-3, "Monitoring of Secondary Side Water Chemistry in PWR Steam Generators," attached to SRP Section 5.4.2.1, "Steam Generator Materials."³⁹
5. EPRI NP-4947-SR, "BWR Hydrogen Water Chemistry Guidelines," October 1988, Electric Power Research Institute.⁴⁰

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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 Materials and Chemical Engineering Branch (EMCB).
2.	Editorial modification	Replaced "direct cycle plants" with "boiling water reactors." NRC regulations do not discuss "direct cycle" and "indirect cycle plants." Although the terms may be used in Regulatory Guides, reference to BWRs and PWRs leaves less opportunity for misunderstanding.
3.	Editorial modification	Changed "and" to "or."
4.	Editorial modification	Replaced "indirect cycle plants" with "pressurized water reactors."
5.	Current PRB designation	Changed PRB to EMCB.
6.	Editorial modification	Items 1 and 2 under AREAS OF REVIEW were duplicative. The two paragraphs have been collapsed into a single paragraph describing the areas of review assigned to EMCB by this SRP section.
7.	SRP-UDP format item	Added "Review Interfaces" to AREAS OF REVIEW.
8.	Editorial modification	Added PRB responsibilities related to water chemistry to identify other SRP sections in which reactor water chemistry is addressed. Hydrogen water chemistry was discussed in SRP Sections 5.2.3, 5.4.8, and 10.4.6 of the ABWR FSER. These discussions should be consistent.
9.	Current PRB designation	Changed PRB to EMCB.

SRP Draft Section 10.4.6**Attachment A - Proposed Changes in Order of Occurrence**

Item	Source	Description
10.	Current review branch designation	Changed the review interface branch to SPLB.
11.	Editorial modification	Replaced "Branch Technical Position" with "BTP."
12.	Editorial modification	Added a sentence to explain the purpose of applying review under SRP Section 3.6.1 to the CCS. GDC 4 is not an acceptance criterion for the CCS.
13.	Current review branch designation	Changed review interface branch to SPLB.
14.	Current review branch designation	Changed review interface branch to PERB.
15.	Current review branch designation	Changed review interface branch to TSB.
16.	Current PRB designation	Changed PRB to EMCB.
17.	Editorial modification	Changed "is" to "are" to provide noun/verb agreement.
18.	Editorial modification	Added initialism and title for GDC to aid the reviewer.
19.	Editorial modification	Used "BWR" instead of "direct cycle plant."
20.	Integrated Impact Number 537	Regulatory Guide 1.56 references ASTM D2187-71. This standard was updated most recently in 1993. After a side-by-side comparison of the two versions, and on approval by the PRB, Regulatory Guide 1.56 should be revised to reference the latest version of the standard.
21.	Editorial modification	Used "PWR" instead of "indirect cycle plant."

SRP Draft Section 10.4.6**Attachment A - Proposed Changes in Order of Occurrence**

Item	Source	Description
22.	SRP-UPD format item	Added "Technical Rationale" and provided lead-in paragraph to ACCEPTANCE CRITERIA.
23.	SRP-UPD format item to develop technical rationale for ACCEPTANCE CRITERIA	Added technical rationale for GDC 14.
24.	Current PRB designation	Changed PRB to EMCB.
25.	Editorial modification	The meaning of this paragraph was not obvious. It was rewritten to clarify that EMCB will provide input to review interface branches, as requested.
26.	Current PRB designation	Changed PRB to EMCB.
27.	Editorial modification	In Section 5.4.2 of the System 80+ FSER, CE stated that secondary water chemistry complies with EPRI Report NP-6239, "PWR Secondary Water Chemistry Guidelines," Revision 2, December 1988. These guidelines are not mentioned in FSER Section 10.4.6. Section 5.4.2 describes other actions to be taken for System 80+ regarding condensate treatment. These review interfaces were added to SRP Section 10.4.6, and a step has been added to REVIEW PROCEDURES to ensure that these sections are coordinated.
28.	Integrated Impact Number 536	Added a reference to EPRI NP-4947-SR used by the staff in the ABWR FSER.
29.	Current review branch designation	Changed review interface branch to SPLB.
30.	Editorial modification	Changed "assure" to "ensure."
31.	Current review branch designation	Changed review interface branch to SPLB.

SRP Draft Section 10.4.6**Attachment A - Proposed Changes in Order of Occurrence**

Item	Source	Description
32.	Current review branch designation	Changed review interface branch to PERB.
33.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
34.	SRP-UDP Format Item, Implement 10 CFR 52 Related Changes	To address design certification reviews a new paragraph was added to the end of the Evaluation Findings. This paragraph addresses design certification specific items including ITAAC, DAC, site interface requirements, and combined license action items.
35.	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.
36.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
37.	Editorial modification	Added the title of SRP Section 3.6.1 to complete the reference.
38.	Editorial modification	Deleted the reference to BTP MEB 3-1. There is no mention of this document in the text of SRP Section 10.4.6. A reference under SRP Section 3.6.1 should be sufficient, without repeating details provided in SRP Section 3.6.1.
39.	Editorial modification	Added the title of SRP Section 5.4..1 to complete the reference.
40.	Integrated Impact Number 536	Added EPRI NP-4947-SR to REFERENCES.

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Attachment B - Cross Reference of Integrated Impacts

Integrated Impact No.	Issue	SRP Subsections Affected
536	Add review of CCS against EPRI NP-4947-SR, "BWR Hydrogen Water Chemistry Guidelines," when a BWR applicant proposes to use hydrogen water chemistry. Add EPRI NP-4947-SR as Reference 5.	III.1.a; VI.5.
537	Regulatory Guide 1.56 references an outdated ASTM standard.	No change. This is a placeholder integrated impact.