



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

10.4.8 STEAM GENERATOR BLOWDOWN SYSTEM (PWR)

REVIEW RESPONSIBILITIES

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

Secondary - None

I. AREAS OF REVIEW

At the construction permit (CP) stage, ~~CMEB~~EMCB² reviews the steam generator blowdown system (SGBS), as described in the applicant's safety analysis report (SAR), in the specific areas that follow. At the operating license (OL) stage, the EMCB³ review consists of confirming the design accepted at the CP stage.

1.⁴

~~CMEB~~EMCB⁵ reviews the SGBS design basis in terms of its ability to remove particulate and dissolved impurities from the steam generator secondary side, thus assisting in maintaining optimum secondary-side water chemistry in steam generators during normal operation, including anticipated operational occurrences (main condenser inleakage and primary-to-secondary leakage). The design basis should include consideration of expected and design flows for all modes of operation (process and process bypass), process design parameters and equipment design capacities, expected and design temperatures for temperature sensitive treatment processes (demineralization and reverse osmosis), and process instrumentation and controls for maintaining operations within established parameter ranges.

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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.

Review Interfaces

1. EMCB performs the following reviews as part of its primary review responsibility under the Standard Review Plan (SRP) sections indicated:⁶
 - ~~2.~~a.⁷ Process sampling capabilities of the SGBS ~~is~~ are⁸ reviewed by ~~EMEB~~EMCB⁹ as part of its primary review responsibility for SRP Section 9.3.2.
 - b. ~~EMEB~~EMCB¹⁰ reviews the secondary coolant chemistry program for steam generator blowdown samples as part of its primary review responsibility for SRP Section 5.4.2.1, BTP MTEB 5-3 (Monitoring of Secondary Side Water Chemistry in PWR Steam Generators).¹¹
2. ~~EMEB~~EMCB¹² will coordinate evaluations of other branches that interface with the overall review of the steam generator blowdown system as follows:
 - a. The Mechanical Engineering Branch (~~MEB~~)(EMEB)¹³ reviews the system's seismic design and quality group classification as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2, respectively.
 - b. ~~Structural Engineering Branch (SEB)~~The Civil Engineering and Geosciences Branch (ECGB)¹⁴ determines the acceptability of the design analysis, procedures, and criteria used to establish the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of natural phenomena, such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles, as part of its primary review responsibility for SRP Sections 3.3.1, 3.3.2, 3.5.3, 3.7.1, 3.7.2, 3.7.3, 3.7.4, 3.8.4, and 3.8.5.
 - c. ~~†~~The liquid, and gaseous, and solid waste treatment aspects of the SGBS are reviewed in SRP Sections 11.2, and 11.3, and 11.4,¹⁵ and the liquid and gaseous process and effluent radiological monitoring ~~is~~ are¹⁶ reviewed in SRP Section 11.5 by ~~Effluent Treatment Systems Branch (ETSB)~~Plant Systems Branch (SPLB)¹⁷ as part of its primary review responsibility for those sections.
 - d. ~~Auxiliary Systems Branch (ASB)~~The SPLB,¹⁸ as part of its primary review responsibility for SRP Section 3.6.1, evaluates the effect of high- and moderate-energy system piping failures to ~~assure~~ ensure¹⁹ that safety-related equipment will not be made inoperable.
 - e. The SPLB²⁰ evaluates the capabilities of the high-energy portion of the SGBS to withstand the effects of internally generated missiles both outside containment in SRP Section 3.5.1.1 and inside containment in SRP Section 3.5.1.2.
 - f. ~~the Containment Systems Branch (CSB)~~The Containment Systems and Severe Accident Branch (SCSB)²¹ determines that the blowdown lines penetrating the primary containment are isolated on a containment isolation signal and evaluates containment isolation dependability (10 CFR 50.34(f)(2)(xiv) and²²

NUREG-0737 Task II.E.4.2) as part of its primary review responsibility in SRP Section 6.2.4.

- g. The review of the quality assurance program is performed by the ~~Quality Assurance Branch~~ Quality Assurance and Maintenance Branch (HQMB)²³ as part of its primary review responsibility for SRP Sections 17.1, ~~and 17.2,~~ and 17.3.²⁴

For those areas of review identified above 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~~EMCB²⁵ accepts the design of the steam generator blowdown system if the relevant requirements of General Design ~~Criterion~~ Criteria²⁶ 1, 2, and 14 are met. The relevant requirements are as follows:

1. General Design Criterion 1 (GDC 1), "Quality Standards and Records,"²⁷ as it relates to system components being designed, fabricated, erected, and tested for quality standards.
2. General Design Criterion 2 (GDC 2), "Design Bases for Protection Against Natural Phenomena,"²⁸ as it relates to system components designed to seismic Category 1 requirements.
3. General Design Criterion 14 (GDC 14), "Reactor Coolant Pressure Boundary,"²⁹ as it relates to secondary water chemistry control ~~are complied with~~³⁰ so that the primary coolant boundary material integrity will be maintained. The steam generator tubes are part of the reactor coolant pressure boundary, and these tubes could be degraded by adverse chemistry conditions on the secondary side. The SGBS primary function is to remove steam generator secondary-side impurities and thus assist in maintaining acceptable secondary-side water chemistry in the steam generators.

Specific criteria necessary to meet the relevant requirements of ~~GDC~~ General Design Criteria³¹ 1, 2, and 14 are as follows:

1. The SGBS is sized to accommodate the design blowdown flow needed to maintain secondary coolant chemistry for normal operation, including anticipated operational occurrences.
2. Equipment capacities are based on design blowdown flow rates and are such that temperature limits for heat-sensitive processes are not exceeded.
3. Instrumentation and automatic controls ensure operation within design parameters.
4. The design of the SGBS is seismic Category I and Quality Group B, from its connection to the steam generator inside primary containment up to and including the first isolation valve outside containment. The design of the SGBS downstream of the outer

containment isolation valves is in ~~accord~~ accordance³² with the provisions of Regulatory Guide 1.143, Position C.1.1.

Technical Rationale

The technical rationale for application of these acceptance criteria to reviewing the steam generator blowdown system is discussed in the following paragraphs:³³

1. GDC 1 requires that structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. The criterion further requires that quality standards be evaluated and that a quality assurance program be established to document compliance with quality requirements.

GDC 1 applies to this section because portions of the steam generator blowdown system constitute part of the reactor coolant pressure boundary, which is subject to quality assurance requirements, and because radioactive materials may be present in liquids processed by the steam generator blowdown system. Regulatory Guide 1.26 describes a quality classification system that can be used to determine quality standards. Regulatory Guide 1.143 provides design guidance relative to quality group classification and quality assurance provisions specific to the steam generator blowdown system. The EMCB review of the steam generator blowdown system is coordinated with HQMB reviews performed under SRP Sections 17.1, 17.2, and 17.3, thereby ensuring that components important to safety are covered by the quality assurance program.

Meeting the requirements of this criterion provides assurance that failure of any component in the steam generator blowdown system will not result in loss of reactor coolant and subsequent fuel damage. Compliance with GDC 1 further ensures that the reactor coolant pressure boundary will not be degraded by adverse secondary water chemistry conditions.³⁴

2. GDC 2 requires that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes.

This criterion applies to SRP Section 10.4.8 because the review identifies portions of the steam generator blowdown system important to safety and considers the seismic classification of materials used in safety-related and nonsafety-related portions of the system. In addition, the criterion applies because radioactive materials may be present in liquids processed by the steam generator blowdown system. Regulatory Guide 1.29 describes a method to be used for identifying and classifying those features that should be designed to withstand the effects of a safe shutdown earthquake. Regulatory Guide 1.143 provides design guidance relative to seismic group classification specific to the steam generator blowdown system.

Meeting the requirements of this criterion provides a level of assurance that the reactor coolant pressure boundary will maintain its integrity after a design basis earthquake.³⁵

3. 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, or gross rupture.

GDC 14 applies to this section because it addresses the capability of the steam generator blowdown system to maintain secondary water chemistry control that will avoid corrosion-induced failure of the reactor coolant pressure boundary.

Meeting the requirements of this criterion for the steam generator blowdown system provides a level of assurance that the probability of leakage from or rapidly propagating failure of the reactor coolant pressure boundary does not increase during the operating life of the plant.³⁶

III. REVIEW PROCEDURES

The reviewer selects and emphasizes material from this SRP section as may be appropriate for a particular case.

1. a. ~~CMEBEMCB~~³⁷ considers the pressure, temperature, flow rate, secondary coolant chemistry, main condenser water inleakage, and primary-to-secondary leakage to determine whether the SGBS design has included the effects of normal operation and anticipated operational occurrences (e.g., main condenser inleakage or primary-to-secondary leakage). ~~CMEBEMCB~~³⁸ determines that the design parameters are reasonable. If the proposed system includes processes which are heat-sensitive (e.g., demineralization or reverse osmosis), ~~CMEBEMCB~~³⁹ verifies that the design includes instrumentation and controls to protect the temperature-sensitive elements. ~~CMEBEMCB~~⁴⁰ ensures that instrumentation and process controls are provided to control flashing, liquid levels, and process flow through the proper components for the radioactivity levels expected.
- b. ~~CMEBEMCB~~⁴¹ reviews the proposed piping and instrumentation diagrams (P&IDs) and process flow diagrams, the method of operation, the processing to be provided, and the interfaces between the blowdown system and other plant systems to determine: (1) whether unusual design conditions exist which could lead to safety problems, and (2) that the system is capable of performing its intended functions.
- c. ~~CMEBEMCB~~⁴² reviews the secondary coolant chemistry program for steam generator blowdown samples in SRP Section 5.4.2.1, BTP MTEB 5-3 (Monitoring of Secondary Side Water Chemistry in PWR Steam Generators).
- d. ~~CMEBEMCB~~⁴³ coordinates its review with ~~MEBEMEB~~⁴⁴ to verify that the assigned classifications at the boundary interfaces between systems and/or system components are in accordance with the importance of the safety function to be performed and the guidelines of Regulatory Guides 1.26, 1.29, and 1.143.

2. ~~SEBECGB~~⁴⁵ determines the seismic design, and ~~MEBEMEB~~⁴⁶ determines the quality group and seismic design classification for the SGBS components as indicated above in subsection I, Areas of Review.
3. ~~ETSBSPLB~~⁴⁷ determines the capability to treat liquid and gaseous wastes associated with the SGBS as part of its review under SRP Sections 11.2 and 11.3.
4. ~~ASBSPLB~~⁴⁸ reviews the effect of SGBS high- and moderate-energy piping failures under SRP Section 3.6.1 to ~~assure~~ ensure that other safety-related systems are not rendered inoperable.

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.⁴⁹

IV. EVALUATION FINDINGS

~~MEBEMCB~~⁵⁰ verifies that sufficient information has been provided and that the review is adequate to support conclusions of the following type, to be included in the staff's safety evaluation report (SER):⁵¹

The steam generator blowdown system (SGBS) controls the concentration of chemical impurities and radioactive materials in the secondary coolant. The scope of review of the SGBS included piping and instrumentation diagrams, seismic and quality group classifications, design process parameters, and instrumentation and process controls. The review has included the applicant's evaluation of the proposed system operation and the applicant's estimate of the controlling process parameters.

The SGBS design meets the primary boundary material integrity requirements of General Design Criterion 14 as it relates to maintaining acceptable secondary water chemistry control during normal operation and anticipated operational occurrences by reducing corrosion of steam generator tubes and materials thereby reducing the likelihood and magnitude of primary-to-secondary coolant leakage.

The SGBS is seismic Category I and Quality Group B from its connection to the steam generator inside primary containment up to and including the first isolation valve outside containment in accordance with Regulatory Guides 1.26 and 1.29 because this portion of the SGBS is considered an extension of primary containment. The SGBS downstream of the outer containment isolation valves is not seismic Category I and meets the quality standards of Position C.1.1 of Regulatory Guide 1.143 since it is not safety related. Thus, the SGBS meets the quality standards requirements of General Design Criterion 1 and seismic requirements of General Design Criterion 2.

Based on the foregoing evaluation, we conclude that the proposed steam generator blowdown system is acceptable.

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.⁵²

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 52.⁵³ 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.⁵⁴

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 1, "Quality Standards and Records."
2. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."
3. 10 CFR Part 50, Appendix A, General Design Criterion 14, "Reactor Coolant Pressure Boundary."
4. Regulatory Guide 1.26, "Quality Group Classifications for Water-, Steam-, and Radioactive-Waste Containing Components of Nuclear Power Plants."
5. Regulatory Guide 1.29, "Seismic Design Classification."
6. Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components in Light-Water-Cooled Nuclear Reactor Power Plants."

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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.	Current PRB designation	Changed PRB to EMCB.
3.	Current PRB designation	Changed PRB to EMCB.
4.	Editorial modification	Deleted the first number. The remaining items in the numbered sequence are now review interface items.
5.	Current PRB designation	Changed PRB to EMCB.
6.	SRP-UDP format item	Added "Review Interfaces" to AREAS OF REVIEW and provided lead-in paragraph.
7.	Editorial modification	Numbered individual review interface items.
8.	Editorial modification	Changed "is" to "are" to provide noun/verb agreement.
9.	Current PRB designation	Changed PRB to EMCB.
10.	Current PRB designation	Changed PRB to EMCB.
11.	Editorial modification	Added review interface for SRP Section 5.4.2.1 for review identified as Review Procedure 1.c.
12.	Current PRB designation	Changed PRB to EMCB.
13.	Current review branch designation	Changed review interface branch to EMEB.
14.	Current review branch designation	Changed review interface branch to ECEB.
15.	Editorial modification	Added SRP Section 11.4 to review interfaces because Regulatory Guide 1.70 identifies the 11.4 review as applicable to SRP Section 10.4.8.

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Attachment A - Proposed Changes in Order of Occurrence

Item	Source	Description
16.	Editorial modification	Changed "is" to "are" to provide noun/verb agreement.
17.	Current review branch designation	Changed review interface branch to SPLB.
18.	Current review branch designation	Changed review interface branch to SPLB.
19.	Editorial modification	Changed "assure" to "ensure" (global change for this section).
20.	Current review branch designation	Changed review interface branch to SPLB.
21.	Current review branch designation	Changed review interface branch to SCSB.
22.	SRP-UDP format item	Added a citation to 10 CFR 50.34(f) but retained the reference to the TMI Action Plan.
23.	Current review branch designation	Changed review interface branch to HQMB.
24.	SRP-UDP format item	Added citation for SRP Section 17.3, which has been drafted as a new SRP section.
25.	Current PRB designation	Changed PRB to EMCB.
26.	Editorial modification	Changed "Criterion" to "Criteria" to accommodate a plural usage.
27.	Editorial modification	Added initialism and title for General Criterion 1, "Quality Standards and Records."
28.	Editorial modification	Added initialism and title for General Criterion 2, "Design Bases for Protection Against Natural Phenomena."
29.	Editorial modification	Added initialism and title for General Design Criterion 14, "Reactor Coolant Pressure Boundary."

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Attachment A - Proposed Changes in Order of Occurrence

Item	Source	Description
30.	Editorial modification	Deleted "are complied with" because it makes no sense. The subject of the sentence is GDC 14.
31.	Editorial modification	Spelled out "GDC" to accommodate plural context.
32.	Editorial modification	Corrected "accord" to "accordance."
33.	SRP-UDP format item	Added "Technical Rationale" to ACCEPTANCE CRITERIA and provided lead-in paragraph.
34.	SRP-UDP format item	Added technical rationale for GDC 1.
35.	SRP-UDP format item	Added technical rationale for GDC 2.
36.	SRP-UDP format item	Added technical rationale for GDC 14.
37.	Current PRB designation	Changed PRB to EMCB.
38.	Current PRB designation	Changed PRB to EMCB.
39.	Current PRB designation	Changed PRB to EMCB.
40.	Current PRB designation	Changed PRB to EMCB.
41.	Current PRB designation	Changed PRB to EMCB.
42.	Current PRB designation	Changed PRB to EMCB.
43.	Current PRB designation	Changed PRB to EMCB.
44.	Current review branch designation	Changed review interface branch to EMEB.
45.	Current review branch designation	Changed review interface branch to ECGB.
46.	Current review branch designation	Changed review interface branch to EMEB.
47.	Current review branch designation	Changed review interface branch to SPLB.
48.	Current review branch designation	Changed review interface branch to SPLB.

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Attachment A - Proposed Changes in Order of Occurrence

Item	Source	Description
49.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
50.	Current PRB designation	Changed PRB to EMCB.
51.	Editorial modification	Provided initialism for "safety evaluation report."
52.	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.
53.	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.
54.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.

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Attachment B - Cross Reference of Integrated Impacts

Integrated Impact No.	Issue	SRP Subsections Affected
	No Integrated Impacts were incorporated in this SRP Section.	