U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

10.4.1 MAIN CONDENSERS

REVIEW RESPONSIBILITIES

Primary - ~~Power Systems Branch (PSB)~~Plant Systems Branch (SPLB)[1]

Secondary - None

I. AREAS OF REVIEW

The main condenser (MC) system is designed to condense and deaerate the exhaust steam from the main turbine and provide a heat sink for the turbine bypass system. For new BWRs without a main steam isolation valve leakage control system (Ref. 3), the MC may also serve an accident mitigation function to act as a holdup volume for the plateout of fission products leaking through the main steam isolation valves following core damage (Ref. 4). [2]

1. The ~~PSB~~SPLB[3] reviews the performance requirements of the main condenser for both direct and indirect cycle plants during all operating conditions. Emphasis will be placed on the review of direct cycle facilities with regard to the prevention of loss of vacuum, corrosion and/or erosion, and hydrogen buildup.

2. The ~~PSB~~SPLB[4] reviews the design of the MC system with respect to the following:

   a. The means to detect, control and facilitate correction of the leakage of cooling water into the condensate; to detect radioactive leakage into or out of the system; and to preclude accidental releases of radioactive materials to the environment in amounts in excess of established limits.

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.

b. Instrumentation and control features that determine and verify that the MC is operating in a correct mode.

c. The means provided to deal with flooding from a complete failure of the MC and to preclude damage to safety-related equipment from the flooding.

d. The capability of the MC to withstand the blowdown effects of steam from the turbine bypass system.

3. The ~~Effluent Treatment Systems Branch~~SPLB[5] evaluates the inventory of radioactive contaminants in the MC during power operation and during shutdown as part of its primary review responsibility for SRP Section 11.5.

4. The ~~Auxiliary Systems Branch~~SPLB[6] determines that safety-related systems and structures are protected from the effects of flooding as part of its primary review responsibility for SRP Section 3.4.1.

5. The review for fire protection is coordinated and performed by the ~~Chemical Engineering Branch~~SPLB[7] as part of its primary review responsibility for SRP Section 9.5.1.

Review Interfaces:[8]

In the review of the Main Condenser, the ~~PSB~~SPLB[9] will coordinate other branch evaluations that interface with the overall review of the system as follows.

A. [10]The Materials and Chemical Engineering Branch (EMCB)[11], upon request of ~~PSB~~SPLB[12], evaluates the adequacy of the materials of construction, the methods used to reduce the corrosion and/or erosion of MC tubes and components, the permissible cooling water inleakage, and the allowed time of operation with inleakage without affecting condensate/feedwater quality for safe reactor operation.

B. The ~~procedures and Test Review Branch~~Quality Assurance and Maintenance Branch (HQMB)[13] determines the acceptability of the preoperational and startup tests as part of its primary review responsibility for SRP Section 14.~~0~~2[14].

~~The reviews for fire protection, technical specifications, and quality assurance are coordinated and performed by the Chemical Engineering Branch, Licensing Guidance Branch, and Quality Assurance Branch as part of their primary review responsibility for SRP Sections 9.5.1, 16.0, and 17.0, respectively.~~[15]

C. The review for technical specifications is coordinated and performed by the ~~Licensing Guidance Branch~~Technical Specifications Branch (TSB)[16] as part of its primary review responsibility for SRP Section 16.0.

D. The review for quality assurance is coordinated and performed by the ~~Quality Assurance Branch~~HQMB[17] as part of its primary review responsibility for SRP Section 17.

E. The Mechanical Engineering Branch (EMEB) determines that the appropriate seismic and quality group classifications have been established for system components as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2.[18]

F. The Civil Engineering and Geosciences Branch (ECGB) performs a seismic analysis of the condenser, if required, as part of its primary review responsibility for SRP Section 3.7.2.[19]

For those areas of review identified above as ~~being~~[20] part of the primary review responsibility of the other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of corresponding primary review[21] branches.

II. ACCEPTANCE CRITERIA

Acceptability of the design of the main condenser system, as described in the applicant's safety analysis report (SAR), is based on meeting the requirements of General Design Criterion 60 (GDC 60) and on the similarity of the design to that of plants previously reviewed and found acceptable.

The design of the Main Condenser System is acceptable if the integrated design of the system meets the requirements of GDC 60 as related to failures in the design of the system which do not result in excessive releases of radioactivity to the environment. In addition, GDC 60 is satisfied if the system is designed such that failures do not cause unacceptable condensate quality, or flooding of areas housing safety-related equipment.

For new BWR plants that do not incorporate an MSIVLCS and for which Main Condenser holdup and plateout of fission products is credited in the analysis of design basis accident radiological consequences, guidance from SECY 93-087 (Reference 4) is applicable as follows:

> A seismic analysis should be performed to ensure that the condenser anchorages and the piping inlet nozzle to the condenser are capable of maintaining their structural integrity during and after an SSE.[22]

Technical Rationale:

The technical rationale for application of the acceptance criterion for the main condensers is discussed in the following paragraphs.[23]

Compliance with GDC 60 requires that provisions be included in the nuclear power unit design to control suitably the release of radioactive materials in gaseous and liquid effluents during normal operation, including anticipated operational occurrences.

GDC 60 is applicable to the design of the MC system because radioactive materials in both gaseous and liquid form are routinely deposited in the main condensers of BWRs during normal operation. In BWRs, the radioactivity in the main steam lines and the air ejector discharge are monitored to ensure that releases are suitably controlled. In PWRs, radioactive materials may be

deposited in the main condensers if there is a primary-to-secondary steam generator tube leak. Measures are taken to detect primary-to-secondary leakage in PWRs by monitoring the radioactivity in the steam generator blowdown and in the air ejector discharge.

Meeting these requirements provides a level of assurance that the release of radioactive materials in gaseous and liquid effluents from the main condensers during normal operation, including anticipated operational occurrences, is kept as low as is reasonably achievable, in accordance with 10 CFR Part 50.[24]

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria and bases and the preliminary design 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. The reviewer will select and emphasize material from this SRP section as may be appropriate for a particular case.

The primary reviewer will coordinate this review with other branches' areas of review as stated in subsection I. The primary reviewer obtains and uses such input as required to assure that this review procedure is complete.

1. The SAR is reviewed to determine that the system description delineates the main condenser system capabilities including the minimum system heat transfer and system flow requirements for normal plant and turbine bypass operation. Measures provided to prevent loss of vacuum, corrosion and/or erosion of MC tubes and components, and hydrogen buildup in the MC are reviewed, with particular emphasis on these measures for direct cycle (boiling water reactor) plants. System performance requirements are reviewed to determine that they satisfactorily limit possible system degradation conditions (e.g., leakage, partial loss of vacuum) and describe the procedures that are followed to detect and correct these conditions. The SAR is ~~also~~[25] reviewed to determine that any allowed MC system degraded operation does not have an adverse effect on the reactor primary system or secondary system in the case of pressurized water reactors. The SAR is also reviewed to determine if the MC will be relied upon for plateout of fission products following core damage (applicable only to new BWRs with no main steam isolation valve leakage control system). If this is the case, a seismic analysis should be performed to ensure that the condenser anchorages and the piping inlet nozzle to the condenser are capable of maintaining their structural integrity during and after an SSE.[26]

2. The reviewer evaluates the MC system design to verify that:

    a. Means have been provided for detecting, controlling and correcting condenser cooling water leakage into the condensate.

b. The permissible cooling water inleakage and time of operation with inleakage are provided to ~~assure~~ensure[27] that condensate/feedwater quality can be maintained within safe limits.

c. Measures have been provided to detect radioactive leakage into and out of the MC system and to preclude unacceptable accidental releases of radioactivity to the environment from the system.

d. The system is provided with instrumentation and control features that determine and verify that the MC is operating in a correct mode.

3. The reviewer uses engineering judgment and the results of failure modes and effects analyses to determine that:

a. The failure of a main condenser and the resulting flooding will not preclude operation of any essential systems. Reference to sections of the SAR describing plant features and the general arrangement and layout drawings will be necessary, as well as the SAR tabulation of seismic design classifications for structures and systems. Statements in the SAR that verify that the above conditions are met are acceptable.

b. The system, in conjunction with the main steam system, has provisions to detect loss of condenser vacuum and to effect isolation of the steam source. For direct cycle plants, it will be acceptable if the detection system in the MC can actuate the main steam isolation valves to limit the quantity of steam ~~lost from~~to[28] the main[29] condenser.

c. Design provisions have been incorporated into the MC that will preclude component or tube failures due to steam blowdown from the turbine bypass system.

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.[30]

IV. EVALUATION FINDINGS

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

The main condenser system (MC) includes all components and equipment from the turbine exhaust to the connections and interfaces with the main condensate and other systems. The scope of review of the main condenser system for the

_____ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the main condenser system and supporting systems that are essential to its operation.

The basis for acceptance of the main condenser system in our review was conformance of the design, design criteria, and design bases to the Commission's regulation as set forth in GDC 60. The staff concludes that the main condenser system design is acceptable and meets the requirements of GDC 60 with respect to failures in the design of the system which do not result in excessive releases of radioactivity to the environment. The applicant has met this requirement by providing ~~radioactive~~radioactivity[31] monitors in the system to detect leakage into and out of the main condenser.

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.[32]

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.[33] 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.[34]

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, "General Design Criterion 60, "Control of Releases of Radioactive Materials to the Environment."

2. Regulatory Guide 1.68, "Initial Test Programs for Water-Cooled Reactor Power Plants."

3. Regulatory Guide 1.96, "Design of Main Steam Isolation Valve Leakage Control Systems for Boiling Water Reactor Nuclear Power Plants."[35]

4. SECY-93-087, "Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (AWLR) Designs," April 2, 1993, paragraph II.E, "Classification of Main Steamlines in Boiling Water Reactors (BWR)," and related SRM dated July 21, 1993, approving the staff position.[36]

SRP Draft Section 10.4.1
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 primary review branch name and designation.	Revised the current primary review branch name and designation, SPLB.
2.	Integrated Impact No. 424.	Added a sentence to indicate that the main condenser may also serve an accident mitigation function in BWRs that have no MSIV leakage control system. Added a citation to References 3 and 4 to indicate the sources of the statements.
3.	Current primary review branch designation.	Revised the current primary review branch designation, SPLB.
4.	Current primary review branch designation.	Revised the current primary review branch designation, SPLB.
5.	Current primary review branch designation.	Due to reorganization, the old interfacing review branch has been replaced by the current primary review branch, SPLB.
6.	Current primary review branch designation.	Due to reorganization, the old interfacing review branch has been replaced by the current primary review branch, SPLB.
7.	Current primary review branch designation.	Due to reorganization, the old interfacing review branch has been replaced by the current primary review branch, SPLB.
8.	SRP-UDP format item.	Added Review Interfaces subheading under Areas of Review.
9.	Current primary review branch designation.	Revised the current primary review branch designation, SPLB.
10.	SRP-UDP format item.	Divided the existing paragraph into paragraphs A. through D. under Review Interfaces. The existing text and order was preserved, except that branch names and designations have been updated as shown, and paragraph E. has been added (a new review interface). Also three reviews were changed from interfacing reviews to primary branch reviews, so paragraphs 3., 4., and 5. were added as shown to the review list for the primary review branch. See footnotes 5, 6, and 7 above.
11.	Current interfacing review branch name and designation.	Revised the current interfacing review branch name and designation, EMCB.
12.	Current primary review branch designation.	Revised the current primary review branch designation, SPLB.
13.	Current interfacing review branch name and designation.	Revised the current interfacing review branch name and designation, HQMB.

Item	Source	Description
14.	Editorial correction.	Revised the reference to read SRP Section 14.2 (Section 14.0 no longer exists).
15.	SRP-UDP format item.	Divided one paragraph into three paragraphs: C. and D. under Review Interfaces for TSB and HQMB; and paragraph 5. for SPLB as primary review branch for fire protection.
16.	Current interfacing review branch name and designation.	Revised the current interfacing review branch name and designation, TSB.
17.	Current interfacing review branch designation.	Revised the current interfacing review branch designation, HQMB.
18.	**Integrated Impact 424**	Added a Review Interface for the seismic classification sections which are applicable to this Section if an MSIVLCS is not used and if the Main Condenser is relied upon for fission product holdup\plateout following a LOCA.
19.	**Integrated Impact 424**	Added a Review Interface for the seismic analysis section which is applicable to this Section if an MSIVLCS is not used and if the Main Condenser is relied upon for fission product holdup\plateout following a LOCA.
20.	Editorial change.	Deleted the superfluous word "being" to improve clarity.
21.	Editorial change.	Added the word "review" to be consistent with prior usage.
22.	**Integrated Impact 424**	Added Acceptance Criteria from SECY 93-087 applicable to Main Condensers credited for fission product holdup and plateout.
23.	SRP-UDP format item.	Added Technical Rationale subheading and introductory paragraph in Acceptance Criteria subsection.
24.	SRP-UDP format item.	Added technical rationale related to GDC 60, "Control of releases of radioactive materials to the environment."
25.	Editorial change.	Deleted the word "also" here to use it in the last sentence in the paragraph.
26.	**Integrated Impact 424**	Added a REVIEW PROCEDURE from SECY 93-087 applicable to Main Condensers credited for fission product holdup and plateout.
27.	Editorial correction.	Changed "assure" to "ensure" for correct usage.

Item	Source	Description
28.	Editorial correction.	The main steam isolation valves close on a loss of condenser vacuum to protect the condenser from overpressure, not to limit any loss of steam from the condenser. As it says in the first sentence, isolation is done to effect isolation of the steam source.
29.	Editorial addition.	Added the word "main" before the word "condenser" to be consistent with prior useage.
30.	SRP-UDP Guidance, Implementation of 10 CFR 52	Added standard paragraph to address application of Review Procedures in design certification reviews.
31.	Editorial correction.	Monitors are provided to detect radioactivity. The monitors are not radioactive.
32.	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.
33.	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.
34.	SRP-UDP Guidance	Added standard paragraph to indicate applicability of this section to reviews of future applications.
35.	Editorial addition.	Added Regulatory Guide 1.96 to the list of references as an editorial aid.
36.	Integrated Impact No. 424.	Added SECY-93-087 to the list of references to indicate the source of the requirement in footnote 2 above.

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Integrated Impact No.	Issue	SRP Subsections Affected
424	Add areas of review on seismic requirements for the main condenser for those BWRs which take credit for main steam line and condenser fission product holdup and plateout, in lieu of a main steam isolation valve leakage control system.	I.,I.E, I.F; II; III.1; VI.4.