



U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

10.4.1 MAIN CONDENSERS

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of power conversion systems

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 (MSIVLCS), 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. The review will be focused on the design features incorporated to control release of radioactive material to the environment.

The specific areas of review are as follows:

1. The design, design objectives, capacity, method of operation, and factors that influence gaseous radioactive material handling, e.g., system interfaces and potential bypass routes. The review includes the system piping and instrumentation diagrams (P&IDs).
2. The means to prevent corrosion and/or erosion of condenser tubes, and detect, control and facilitate correction of the leakage of cooling water into the condensate.

Revision 3 - March 2007

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 Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

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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3. The means 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.
4. Instrumentation and control features that determine and verify that the MC is operating in a correct mode.
5. 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.
6. The capability of the MC to withstand the blowdown effects of steam from the turbine bypass system.
7. If the potential for explosive mixtures exist, design features to preclude the possibility of an explosion which could cause a release of radioactive material to the environment.
8. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.
9. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other SRP sections interface with this section as follows:

1. Review of the acceptability of the seismic and quality group classifications is performed under SRP Sections 3.2.1 and 3.2.2.
2. Review to determine that safety-related systems and structures are protected from the effects of flooding from a complete failure of the MC is performed under SRP Section 3.4.1.
3. Review of seismic analyses is performed under SRP Section 3.7.2.
4. Review of the instrumentation in place to monitor condensate quality and detect MC tube leakage is performed under SRP Section 9.3.2.

5. Review of fire protection is performed under SRP Section 9.5.1.
6. Review of the measures in place to monitor the inventory of radioactive materials in the MC and detect radioactive leakage into or out of the system is performed under SRP Section 11.5.
7. Review of technical specifications is performed under SRP Section 16.0.
8. Review of quality assurance is performed under SRP Chapter 17.

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

II. ACCEPTANCE CRITERIA

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. Acceptability of the design of the MC 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 MC 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.

2. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations;
3. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in 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.

1. The requirements of GDC 60 are met when the MC design includes provisions to prevent excessive releases of radioactivity to the environment which may result from a failure of a structure, system or component in the MC. Acceptance is based on meeting the following:
 - A. SECY 93-087 gives guidance for new BWR plants that do not incorporate an MSIVLCS and for which MC holdup and plateout of fission products is credited in the analysis of design basis accident radiological consequence. It states that seismic analyses are to 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.
 - B. If there is a potential for explosive mixtures to exist, the MC is designed to withstand the effects of an explosion and instrumentation is provided to detect and annunciate the buildup of potentially explosive mixtures, dual instrumentation is provided to detect, annunciate, and effect control measures to prevent the buildup of potentially explosive mixtures, as outlined in SRP Section 11.3, subsection II, "Acceptance Criteria," SRP Acceptance Criteria, Item 6.

Technical Rationale

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

1. 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 MC of BWRs during normal operation. 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 prevent uncontrolled release of these radioactive materials to the environment.

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 50, Appendix I.

III. REVIEW PROCEDURES

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

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the

proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

1. The SAR is 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.
2. The reviewer evaluates the MC system design to verify that:
 - A. Means have been provided for controlling and correcting condenser cooling water leakage into the condensate.
 - B. Upon request, the MC system is reviewed for the compatibility of the materials of construction with the service conditions and the methods used to reduce the corrosion and/or erosion of MC tubes and components.
3. The reviewer uses engineering judgment and the results of failure modes and effects analyses to determine that:
 - A. The failure of a MC 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. Statements in the SAR that verify that the above conditions are met are acceptable.
 - B. If there is a potential for explosive mixtures to exist, the MC is designed to withstand the effects of an explosion and instrumentation is provided to detect and annunciate the buildup of potentially explosive mixtures, dual instrumentation is provided to detect, annunciate, and effect control measures to prevent the buildup of potentially explosive mixtures, as outlined in SRP Section 11.3, subsection II, "Acceptance Criteria," Section B. Item 6.
 - C. 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 to the MC.
 - D. 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 review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

IV. EVALUATION FINDINGS

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.

The main condenser (MC) system, includes all components and equipment from the turbine exhaust to the connections and interfaces with the main condensate and other systems. The system design has been reviewed and found to meet the requirements of General Design Criteria 60. The basis for acceptance of the MC 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 MC 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 design features to preclude uncontrolled radioactive material leakage into and out of the MC.

For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

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 submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

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

2. 10 CFR Part 50, Appendix I, "Numerical Guides For Design Objectives and Limiting Conditions For Operation to Meet the Criterion "As Low as is Reasonably Achievable" For Radioactive Material in Light Water Cooled Nuclear Power Reactor Effluents."
3. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; And Combined Licenses For Nuclear Power Plants."
4. U.S. Nuclear Regulatory Commission. "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)," SECY-93-087. Washington, DC. April 2, 1993, and related SRM dated July 21, 1993.

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the 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.
