U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

6.7 MAIN STEAM ISOLATION VALVE LEAKAGE CONTROL SYSTEM (BWR)

REVIEW RESPONSIBILITIES

Primary - Auxiliary Systems Branch (ASB)

Secondary - None

I. AREAS OF REVIEW

Direct cycle boiling water reactor (BWR) plants have redundant quick-acting isolation valves on each main steam line from the reactor to the turbine. In the event of a loss-of-coolant accident (LOCA), any leakage of contaminated steam through these valves is controlled by a leakage control system. The leakage control system must satisfy the requirements of General Design Criteria 2, 4, and 54.

The review of the main steam isolation valve leakage control system (MSIVLCS) covers the entire leakage control system including the source of the sealing medium, if any, and pumps, valves, and piping to the points of connection or interface with the main steam supply system. Emphasis is placed on the components of the leakage control system that are required to remain functional following a design basis LOCA.

1. ASB reviews the design of the MSIVLCS and essential subsystems to assure their ability to function following a postulated LOCA including the loss of offsite power. The system is reviewed to determine that:

   a. A malfunction or failure of an active component of the system, or loss of the source of sealing fluid, if any, will not impair the functional performance of the system.

   b. The failure of nonseismic Category I equipment or components will not have an adverse effect on the ability of the system or components to function.

   c. The capability of the system to perform its intended safety function is maintained assuming a single active failure of a main steam line isolation valve.

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. The ASB also reviews the design of the leakage control system with respect to the following:

   a. The capability of the system to withstand the effects of the safe shutdown earthquake, including the source of sealing medium, if any.

   b. The capability of the system to control main steam isolation valve leakage and preserve containment integrity under design basis LOCA conditions, including loss of offsite power.

   c. The compatibility of initiation means and controls of the system with loading requirements on the emergency electrical buses, operator reaction times, and with actuation times available in view of the specified main steam isolation valve leakage limits.

   d. The requirements for interlocks to prevent inadvertent system operation.

   e. The capability of the system design to permit functional testing of components, controls, and actuation devices during power operations to the extent practicable and complete functional testing during plant shutdown.

   f. The capability of the system and main steam supply system components to withstand effects resulting from the use of a sealing medium, if any, such as thermal stresses, pressures associated with flashing, and thermal deformations, so that the structural integrity of the main steam lines and main steam isolation valves will not be affected and that any deformation of valve internals will not result in excessive leakage from or through the valves.

   g. The design provisions incorporated to prevent or treat main steam isolation valve stem packing leakage or other direct leakage.

   h. The instrumentation and control features necessary to accomplish the system function, including isolation of components of the system in the event of malfunctions.

   i. The need for a third main steam shutoff valve in each main steam line upstream of the turbine stop valve to assure the safety function of the MSIVLCS.

3. ASB also performs the following reviews under the SRP sections indicated:

   a. Review for flood protection is performed under SRP Section 3.4.1.

   b. Review of the protection against internally generated missiles is performed under SRP Section 3.5.1.1.

   c. Review of the structures, systems, and components to be protected against externally generated missiles is performed under SRP Section 3.5.2.

   d. Review of protection against pipe breaks is performed under SRP Section 3.6.1.

Related review evaluations will be performed by other branches and the results will be coordinated by ASB to complete the overall evaluation of the system. The evaluations provided by other branches are as follows. The Structural Engineering Branch (SEB) determines the acceptability of the design analyses, 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 earthquakes (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 through 3.7.4, 3.8.4, and 3.8.5. The Mechanical Engineering Branch (MEB) determines that the components piping and structures are designed in accordance with applicable codes and standards as part of its primary review responsibility for SRP Sections 3.9.1 through 3.9.3. The MEB also determines the acceptability of the seismic and quality group classifications for system components as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2. The MEB also reviews the adequacy of the inservice testing program of pumps and valves as part of its primary review responsibility for SRP Section 3.9.6. The Materials Engineering Branch (MTEB) verifies that inservice inspection requirements are met for system components as part of its primary review responsibility for SRP Section 6.6, and, upon request, verifies the compatibility of the materials of construction with service conditions. The Equipment Qualification Branch (EQB) reviews the seismic qualification of Category I instrumentation and electrical equipment and the environmental qualification of mechanical and electrical equipment as part of its primary review responsibility for SRP Sections 3.10 and 3.11, respectively. The Instrumentation and Control Systems Branch (ICSB) and the Power Systems Branch (PSB) determine the adequacy of the design, installation, inspection, and testing of all electrical components (sensing, control, and power) required for proper operation as part of their primary review responsibility for SRP Sections 7.1 and 8.0, respectively. The Containment Systems Branch (CSB) reviews the MSIVLCS to assure that no malfunction can adversely affect containment integrity as part of its primary review responsibility for SRP Sections 6.2.1 and 6.2.4. The review 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.

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 corresponding to those branches.

II. ACCEPTANCE CRITERIA

Acceptability of the MSIVLCS, as described in the applicant's safety analysis report (SAR), is based on specific general design criteria and regulatory guides. An additional basis for determining the acceptability of the MSIVLCS is the degree of similarity of the design with that of previously reviewed plants.

The design of the MSIVLCS is acceptable if the integrated system design is in accordance with the following criteria:

1. General Design Criterion 2, as related to structures housing the system and the system itself being capable of withstanding the effects of earthquakes. Acceptance is based on meeting position C.1 of Regulatory Guide 1.29 and position C.1 of Regulatory Guide 1.96.

2. General Design Criterion 4, as related to structures housing the system and the system itself being capable of withstanding the effects of pipe breaks and externally and internally generated missiles. Acceptance is based on meeting positions C.2 and C.4 of Regulatory Guide 1.96.

3. General Design Criterion 54, as related to the capability for leak detection, isolation, and performance testing for system piping penetrating containment. Acceptance is based on meeting positions C.3 and C.5 through C.12 of Regulatory Guide 1.96.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to determine that the design criteria, design bases, and preliminary design meet the acceptance criteria given in subsection II of this SRP section. For the review of operation license (OL) applications, the procedures are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design. The OL review includes a determination that the content and intent of the technical specifications prepared by the applicant are in agreement with the requirements for system testing, minimum performance, and surveillance developed by the staff. The reviewer will select and emphasize material from this SRP section, as may be appropriate for a particular case.

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

1. The information provided in the SAR pertaining to the design basis and design criteria, the system piping and instrumentation diagrams (P&IDs), and the system description are reviewed to determine that they clearly delineate the following:

   a. The method used to accomplish the main steam isolation valve leakage control function and the system components essential for operation following design basis LOCA conditions.

   b. Essential components of the leakage control system are correctly identified and are isolable from any nonessential portions of the system. The P&IDs are reviewed to verify that they clearly indicate the physical divisions between such portions and indicate any design classification changes. System drawings are reviewed to see that they show the means for accomplishing isolation and the system description is reviewed to identify minimum performance requirements for the leakage control system isolation valves.

   c. Essential components of the leakage control system, including the isolation valves separating any nonessential portions of the system, and the seal fluid source (if used) are classified seismic Category I and Quality Group A or B, as specified in Regulatory Guide 1.96. Component and system descriptions in the SAR that identify mechanical and performance characteristics are reviewed to verify that the above classifications have been included, and that the P&IDs indicate points of design classification changes. The review for seismic design is performed by SEB and the review for seismic and quality group classification is performed by MEB, as indicated in subsection I of this SRP section.

d. Design provisions have been made that permit appropriate inservice inspection and functional testing of system components. It is acceptable if the SAR information delineates a testing and inspection program and if the system drawings show the necessary design provisions to accomplish the testing program.

2. The reviewer determines that the safety function of the MSIVLCS will be maintained, as required, in the event of adverse environmental phenomena such as earthquakes. The reviewer uses engineering judgment, the results of failure modes and effects analyses, and the results of reviews performed under other SRP sections indicated in subsection I of this SRP section to determine that the failure of nonessential portions of the system or of other systems not designed to seismic Category I and located close to essential portions of the system, or of nonseismic Category I structures located close to essential portions of the system, will not preclude operation of the essential portions of the MSIVLCS. Reference to SAR sections describing site features, the general arrangement and layout drawings, and the tabulation of seismic design classifications for systems and structures will be necessary. Statements in the SAR that the above conditions are met are acceptable.

3. If the leakage control system is one using a fluid sealing medium:

   a. The system design is reviewed to determine that the quantity of sealing fluid needed for an effective seal of the valves has been provided. Independent analyses, using the pump performance curves in the SAR, are made to assure that the design and the location of the pump and components are such as to maintain the appropriate net positive suction head (NPSH) requirements and provide a continuous supply of sealing fluid during the full course of an accident.

   b. The system design is reviewed to determine that effects resulting from the sealing fluid, such as thermal stresses, pressures associated with flashing, thermal deformations, and other effects will not effect the structural integrity of the steam lines or the main steam isolation valves, or lead to excessive leakage of the valves. This portion of the review is done on a case-by-case basis. The ASB also accepts the system design if a statement in the SAR commits to performing calculations or functional testing to demonstrate that the above conditions are met.

4. The MSIVLCS is reviewed to verify that instrumentation, controls, and interlocks designed to standards appropriate for an engineered safety feature are provided to actuate the system in the event of a design basis LOCA, and to prevent inadvertent actuation. Interlocks to prevent inadvertent operation of the leakage control system that are actuated by signals from the reactor protection, engineered safety feature, or containment isolation systems are acceptable. A statement in the SAR that such instrumentation, controls, and interlocks will be provided is acceptable for construction permit (CP) review.

5. The system performance requirements, P&IDs, MSIVLCS drawings, and the results of failure modes and effects analyses are reviewed to assure that the system can function following a design basis LOCA assuming a concurrent single active failure, including the failure of a single main steam isolation valve to close. The reviewer evaluates the analyses presented in

the SAR to assure the function of required components, traces the availability of these components on system drawings, and checks that the SAR contains verification that minimum requirements are met for each failure condition over the required time spans. For each case the design is acceptable if minimum system functional requirements are met. The reviewer upon request from AEB provides an estimate of the quantity of fluid processed by the MSIVLCS, for use in calculating radiological consequences of a LOCA.

6. The leakage control system design is reviewed to verify that valve stem packing leakage or other direct leakage from the main steam isolation valves or other components outside containment is prevented or controlled. Such leakage could bypass the leakage control system and result in untreated releases to the environment. The means for prevention or control need not be part of the leakage control system itself, but should meet the same design criteria.

7. The leakage control system design is reviewed to determine if a third main steam line valve, located between the main steam isolation valve and the turbine stop valve, is required to assure that the MSIVLCS can perform its safety function following a design basis LOCA.

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 steam isolation valve leakage control system (MSIVLCS) includes [the source of the sealing medium, (if used)] pumps, valves, and piping to the points of connection or interface with the main steam lines. The system is designed to seismic Category I, Quality Group B requirements since it is necessary for postaccident fission product removal. That portion of the system connected to the piping between the MSIVs is designed to seismic Category I, Quality Group A requirements since it is part of the primary coolant system pressure boundary. Based on the review of the applicant's proposed design criteria, design bases, safety classification of system and components, and the requirements for operation of the system during loss-of-coolant accident conditions, the staff concludes that the design of the main steam isolation valve leakage control system is in conformance with the Commission's regulations as set forth in General Design Criteria 2, 4, and 54. This conclusion is based on the following:

1. The applicant's design meets the requirements of General Design Criterion 2 since the design is in accordance with position C.1 of Regulatory Guide 1.29 and position C.1 of Regulatory Guide 1.96.

2. The applicant's design meets General Design Criterion 4 with regards to pipe breaks and missiles since the design meets positions C.2 and C.4 of Regulatory Guide 1.96.

3. The applicant's design also meets the requirements of General Design Criterion 54 as related to leak detection, isolation, and performance testing for system piping penetrating containment. The bases for acceptance is that the design meets positions C.3 and C.5 through C.12 of Regulatory Guide 1.96.

V. IMPLEMENTATION

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

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 compliance with Commission regulations.

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 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

3. 10 CFR Part 50, Appendix A, General Design Criterion 54, "Piping Systems Penetrating Containment."

4. Regulatory Guide 1.29, "Seismic Design Classification."

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