



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

SECTION 6.7

MAIN STEAM ISOLATION VALVE LEAKAGE CONTROL SYSTEM (BWR)

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

Secondary - Reactor Systems Branch (RSB)
 Structural Engineering Branch (SEB)
 Mechanical Engineering Branch (MEB)
 Materials Engineering Branch (MTEB)
 Electrical, Instrumentation and Control Systems Branch (EICSB)

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 review of the main steam isolation valve leakage control system (MSIVLCS) is applicable to direct cycle BWR plants. The review 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 during design basis LOCA conditions.

1. APCSB reviews the ability of the MSIVLCS and essential subsystems to function during and subsequent to postulated LOCA conditions, 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 reduce the functional performance of the system.
 - b. The failure of non-seismic Category I equipment or components will not have an adverse effect on the system or components.
 - c. The capability of the system to perform its intended safety function is maintained assuming a single active failure of a main steam isolation valve.

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

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 Revision 2 of 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. 20545.

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- 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 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 isolation valves will not be affected and that any deformation of valve internals will not induce excessive leakage 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 use of applicable codes and standards and assignment of appropriate seismic and quality group classifications.
3. The applicant's proposed technical specifications are reviewed at the operating license stage as they relate to areas covered in this plan.

Secondary review evaluations are performed by other branches and the results used by APCS8 to complete the overall evaluation of the system. The evaluations provided by other branches are as follows. The SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of structures housing the system and supporting systems to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE). The MEB reviews the seismic qualification of components and confirms that components and piping are designed in accordance with applicable codes and standards. The RSB determines that the assigned seismic and quality group classifications for system components are acceptable.

The MTEB verifies that inservice inspection requirements are met for system components and, upon request, verifies the compatability of the materials of construction with service conditions. The EICSB determines the adequacy of the design, installation, inspection and testing of all electrical components (sensing, control, and power) required for proper operation.

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 natural phenomena such as earthquakes, as established in Chapters 2 and 3 of the SAR.
2. General Design Criterion 4, as related to structures housing the system and the system itself being capable of withstanding the effects of externally and internally generated missiles.
3. General Design Criterion 54, as related to the capability for leak detection, isolation, and performance testing for system piping penetrating containment.
4. Regulatory Guide 1.96, as related to the design of the MSIVLCS.

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 Section II. 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 plan, as may be appropriate for a particular case.

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 in design basis LOCA conditions.

- b. Essential components of the leakage control system are correctly identified and are isolable from any non-essential portions of the system. The PID's 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 isolation valves.
 - c. Essential components of the leakage control system, including the isolation valves separating any non-essential 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.
 - 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 review plans to determine that the failure of non-essential portions of the system or of other systems not designed to seismic Category I standards and located close to essential portions of the system, or of non-seismic Category I structures 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.

Acceptability may be based on a comparative analysis of system parameters and capabilities to similarly designed systems previously found acceptable. The APCS 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 also provides the Accident Analysis Branch with 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 standards.

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 scope of review of the MSIVLCS for the _____ plant included layout drawings, piping and instrumentation diagrams, and descriptive information for the system and supporting systems that are essential to its operation. [The review has determined the adequacy of the applicant's

proposed design criteria and design bases and the requirements for operation of the system during loss-of-coolant accident conditions. (CP)] [The review has determined that the design of the MSIVLCS and supporting systems is in conformance with the proposed design criteria and bases. (OL)]

"The basis for acceptance in the staff review has been conformance of the applicant's designs, design criteria, and design bases for the MSIVLCS and supporting systems to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, staff technical positions, and industry standards.

"The staff concludes that the design of the MSIVLCS conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

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

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