U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

5.4.12 REACTOR COOLANT SYSTEM HIGH POINT VENTS

REVIEW RESPONSIBILITIES

Primary - Reactor Systems Branch (RSB)

Secondary - None

I. AREAS OF REVIEW

Reactor coolant system high point vents are provided to exhaust noncondensible gases from the primary system that could inhibit natural circulation core cooling. The vent system consists of remotely operated valves at high points in the reactor coolant system to vent gases from the primary system into containment. Since the vents form part of the reactor coolant pressure boundary, design of the vent system shall conform to the requirements of Appendix A to 10 CFR Part 50, "General Design Criteria." In addition, the vent system shall be designed with sufficient redundancy to assure a low probability of inadvertent or irreversible actuation. The vent system's safety function may be required to maintain core coolability following an accident, therefore the system is designed as a safety-related system. RSB review of reactor coolant system high point vents will include the following specific areas:

1. The location, size, discharge capacity, functions, and discharge area(s) of the vent system.

2. Supporting LOCA analyses for breaks in the vent line to demonstrate compliance with 10 CFR Part 50, §50.46.

3. Redundancy and failure modes of the valve train.

4. Procedures for using and not using the vent system, and the bases for these procedures.

5. Information available to the operator for initiating and terminating vent system operation.

In addition, the RSB will coordinate other branch evaluations that interface with the overall review of the system 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 earthquake (SSE), 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. In addition, MEB reviews the adequacy of the inservice testing program of 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 Instrumentation and Control Systems Branch (ICSB) and the Power Systems Branch (PSB) determine the adequacy of the design, installation, inspection, and testing of all essential electrical components (sensing, control, and power) required for proper operation as part of their primary review responsibility for SRP Sections 7.1 and 8.1, respectively. The Containment Systems Branch (CSB) reviews the acceptability of mixing of discharged gases within the containment atmosphere and assures that containment design limits will not be exceeded by venting during an accident condition as part of its primary responsibility for SRP Sections 6.2.1 through 6.2.6. The Equipment Qualification Branch (EQB) reviews the acceptability of the environmental qualification of all vent system components as part of its primary review responsibility for SRP Sections 3.10 and 3.11. The Procedure and Test Review Branch (PTRB) reviews the vent systems testability, operability, and the procedures for operator use during accident conditions as part of its primary review responsibility for SRP Section 14.2. The review of technical specifications is coordinated and performed by the Licensing Guidance Branch (LGB) as part of its primary review responsibility for SRP Section 16.0.

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 identified as the primary review responsibility of those branches.

II. ACCEPTANCE CRITERIA

The objective of the review is to determine that the vent system is capable of removing noncondensible gases from the primary coolant system with a minimal probability of inadvertent or spurious actuation.

RSB acceptance criteria are based on meeting the relevant requirements of the following regulations:

A. 10 CFR Part 50, §50.55a and General Design Criteria 1 and 30 as they relate to the vent system components which are part of the reactor coolant pressure boundary being designed, fabricated, erected, and tested and maintained to high quality standards.

B. General Design Criterion 14, as it relates to the reactor coolant pressure boundary being designed, fabricated, erected and tested to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture.

C. 10 CFR Part 50, §50.46(b) as it relates to the long-term cooling of the core following any calculated successful initial operation of the ECCS to remove decay heat for an extended period of time.

Specific criteria necessary to meet the regulations identified above and necessary to implement task action plan Item II.B.1 of NUREG-0718 and -0737 are as follows:

1. Vent paths shall be provided on high points of the reactor coolant system (including the pressurizer on PWRs) to vent gases which may inhibit core cooling. For reactors with U-tube steam generators, procedures shall be developed to remove gases from the U-tubes since it is impractical to individually vent the thousands of U-tubes.

2. A single failure of a vent valve, power supply, or control system shall not prevent isolation of the vent path. On BWRs, block valves are not required in lines with safety valves used for venting.

3. Sufficient redundancy in the design shall be incorporated to minimize the probability of inadvertent actuation. Other methods to reduce the chances of inadvertent actuation, such as removing power or administrative controls, may be considered.

4. Since the reactor coolant system vent will be part of the reactor coolant system pressure boundary, all requirements for the reactor pressure boundary must be met.

5. The size of the vent line should be kept smaller than the size corresponding to the definition of a LOCA (10 CFR Part 50, Appendix A) to avoid unnecessary challenges to the ECCS.

6. Vent paths to the containment should discharge into areas that provide good mixing with containment air and are able to withstand steam, water, noncondensibles, and mixtures of the above.

7. The vent system shall be operable from the control room and provide positive valve position indication. Power shall be supplied from emergency buses.

8. It is important that the displays and controls added to the control room as a result of this requirement not increase the potential for operator error. A human-factor analysis should be performed taking into consideration:

   (a) the use of this information by an operator during both normal and abnormal plant conditions,

   (b) integration into emergency procedures,

   (c) integration into operator training, and

(d) other alarms during emergency and need for prioritization of alarms.

9. Provisions to test for operability of the reactor coolant vent system should be a part of the design. Testing should be performed in accordance with subsection IWV of Section XI of the ASME Code for Category B valves.

10. The reactor coolant vent system (i.e., vent valves, block valves, position indication devices, cable terminations, and piping) shall be seismically and environmentally qualified in accordance with IEEE 344-1975 as supplemented by Regulatory Guide 1.100, 1.92 and SEP 3.92, 3.43, and 3.10. Environmental qualifications are in accordance with the May 23, 1980 Commission Order and Memorandum (CLI-80-21).

11. Procedures to effectively operate the vent system must consider when venting is needed and when it is not needed. A variety of initial conditions from which venting may be required shall be considered. Operator actions and the necessary instrumentation shall be identified.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) review to assure that the design criteria and bases and the preliminary design as set forth in the Preliminary Safety Analysis Report meet the acceptance criteria given in subsection II.

For operating licence (OL) reviews, the procedures are utilized 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 OL review also includes the proposed technical specifications, to assure that they are adequate in regard to limiting conditions of operation and periodic surveillance testing.

The reviewer will select and emphasize material from this SRP section, as may be appropriate for a particular case.

1. RSB reviews the vent system description to determine that the vent paths are capable of venting reactor coolant system high points. For areas that may be impractical to vent, such as the U-tubes in steam generators, the reviewer determines that adequate procedures have been developed to assure coolability.

2. At RSB request, ICSB reviews the instrumentation, vent controls, and power source to establish that a single failure will not prevent isolation of the vent system.

3. RSB examines valve redundancy and other methods to minimize inadvertent actuation. Comparisons of the methods to prevent inadvertent actuation should be made with other safety-related systems.

4. MTEB evaluates the vent system to determine that all requirements for the reactor pressure boundary are met.

5. RSB examines the size of the vent line and orifices to see that they are smaller than the LOCA definition. If vent path capacity is of LOCA size, a LOCA analysis shall be provided.

6. RSB determines that the areas of discharge for the vent system are capable of withstanding all substances which may be vented. In addition CSB examines these areas to see that adequate mixing with the containment atmosphere is provided.

7. RSB examines the description and P&IDs to assure that the vents are operable from the control room and that power is supplied from emergency ency buses.

8. HFEB determines that the displays and controls added to the control room as a result of this requirement do not increase the potential for operator error. A human-factor analysis will be evaluated taking into consideration:

   (a) the use of this information by an operator during both normal and abnormal plant conditions,

   (b) integration into emergency procedures,

   (c) integration into operator training, and

   (d) other alarms during emergency and need for prioritization of alarms.

9. PRTB examines provisions to test for operability of the reactor coolant vent system. Testing should be performed in accordance with subsection IWV of Section XI of the ASME Code for Category B valves.

10. EQB reviews the reactor coolant vent system (i.e., vent valves, block valves, position indication devices, cable terminations, and piping) to assure that it is seismically and environmentally qualified in accordance with IEEE 344-1975 as supplemented by Regulatory Guide 1.100, 1.92 and SEP 3.92, 3.43, and 3.10.

11. RSB evaluates the procedures necessary to operate the vent system. The operating procedures shall consider the following:

    a. When venting is needed and when it is not needed.

    b. The method for determining the size of a noncondensible bubble.

    c. A variety of initial conditions from which venting may take place.

    d. Operator actions and necessary instrumentation.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided and that the review supports conclusions of the following type, to be included in the staff's Safety Evaluation Report:

> The staff concludes that the design of the reactor coolant system high point vents is acceptable and meets the relevant requirements of 10 CFR Part 50, §50.46 and §50.55a, General Design Criteria 1, 14, and 30. This conclusion is based on the following:

The reactor coolant system high point vents includes components and piping to remotely relieve noncondensible gases from the primary coolant system and vent the gases to the containment atmosphere or to holdup tanks within containment. [The review has included the applicant's proposed design criteria and design bases, and these meet the requirements for the Construction Permit Stage.] {The review has included the applicant's analysis of the vent system design with the design criteria and design bases and has included operating procedures for the vents.] (Operating License Stage)

In addition, the basis for acceptance in the staff review is conformance of the applicant's designs, design criteria, and design bases for the reactor coolant system vents and supporting systems to applicable regulatory guides, branch technical positions, and industry standards [identify each document and describe how the applicant has implemented each].

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans 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 conformance with Commission regulations.

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

VI. REFERENCES

1. 10 CFR Part 50, §50.46, "Acceptance Criteria for Light Water Nuclear Power Reactors."

2. 10 CFR Part 50, §50.55a, "Codes and Standards."

3. 10 CFR Part 50, Appendix A, General Design Criterion 1, "Quality Standards and Records."

4. 10 CFR Part 50, Appendix A, General Design Criterion 14, "Reactor Coolant Pressure Boundary."

5. 10 CFR Part 50, Appendix A, General Design Criterion 30, "Quality of Reactor Coolant Pressure Boundary."

6. NUREG-0718, "Licensing Requirements for Pending Applications for Construction Permits and Manufacturing Licenses."

7. NUREG-0737, "Clarification of TMI Action Plan Requirements."