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(Formerly NUREG-75/087)

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

6.2.4 CONTAINMENT ISOLATION SYSTEM

REVIEW RESPONSIBILITIES

Primary - Containment Systems Branch (CSB)

Secondary - None

I. AREAS OF REVIEW

The design objective of the containment isolation system is to allow the normal or emergency passage of fluids through the containment boundary while preserving the ability of the boundary to prevent or limit the escape of fission products that may result from postulated accidents. This SRP section, therefore, is concerned with the isolation of fluid systems which penetrate the containment boundary, including the design and testing requirements for isolation barriers and actuators. Isolation barriers include valves, closed piping systems, and blind flanges.

The CSB review of the applicant's safety analysis report (SAR) regarding containment isolation provisions covers the following aspects:

1. The design of containment isolation provisions, including:

   a. The number and location of isolation valves, i.e., the isolation valve arrangements and the physical location of isolation valves with respect to the containment.

   b. The actuation and control features for isolation valves.

   c. The positions of isolation valves for normal plant operating conditions (including shutdown) postaccident conditions, and in the event of valve operator power failures.

   d. The valve actuation signals.

   e. The basis for selection of closure times of isolation valves.

   f. The mechanical redundancy of isolation devices.

g. The acceptability of closed piping systems inside containment as isolation barriers.

2. The protection provided for containment isolation provisions against loss of function of missiles, pipe whip, and earthquakes.

3. The environmental conditions inside and outside the containment that were considered in the design of isolation barriers.

4. The design criteria applied to isolation barriers and piping.

5. The provisions for detecting a possible need to isolate remote-manual-controlled systems, such as engineered safety features systems.

6. The design provisions for and technical specifications pertaining to operability and leakage rate testing of the isolation barriers.

7. The calculation of containment atmosphere released prior to isolation valve closure for lines that provide a direct path to the environs.

CSB will coordinate other branch evaluations that interface with the overall review of the containment isolation system, as follows: The Mechanical Engineering Branch (MEB) will review the system seismic design and quality group classification as part of its primary review responsibility for SRP Sections 3.2.1 and 3.2.2, respectively. The Structural Engineering Branch (SEB) and the MEB will review the mechanical and structural design of the containment isolation system as part of their primary review responsibilities for SRP Sections 3.8 and 3.9, respectively, to ensure adequate protection against a breach of integrity, missiles, pipe whip, jet impingement and earthquakes. The Instrumentation and Control Systems Branch (ICSB), as part of its primary responsibility for SRP Section 7.5, will evaluate the actuation and control features for isolation valves. The Equipment Qualification Branch (EQB), as part of its primary review responsibility for SRP Sections 3.10 and 3.11, will evaluate the qualification test program for electric valve operators, and sensing and actuation instrumentation of the plant protection system located both inside and outside of containment; and the operability assurance program for containment isolation valves. The Accident Evaluation Branch (AEB), as part of its primary review responsibility for SRP Section 15.6.5, will review the radiological dose consequence analysis for the release of containment atmosphere prior to closure of containment isolation valves in lines that provide a direct path to the environs. The Reactor Systems Branch (RSB), as part of its primary review responsibilities for SRP Section 15.6.5, will review the closure time for containment isolation valves in lines that provide a direct path to the environs, with respect to the prediction of onset of accident-induced fuel failure. The review of proposed technical specifications, at the operating license stage of review, pertaining to operability and leakage rate testing of the isolation barriers, and the closure time for containment isolation valves, is 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 reviewed as part of the primary review responsibility of other branches, the acceptance criteria necessary for the review and their methods of application are contained in the referenced SRP section of the corresponding primary branch.

II. ACCEPTANCE CRITERIA

The CSB will accept the containment isolation system design if the relevant requirements of General Design Criteria 1, 2, 4, 16, 54, 55, 56, and 57 and Appendix K to 10 CFR Part 50 are met. The relevant requirements are as follows:

1. General Design Criteria 1, 2, and 4 as they relate to systems important to safety being designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed; systems being designed to withstand the effects of natural phenomena (e.g., earthquakes) without loss of capability to perform their safety functions; and systems being designed to accommodate postulated environmental conditions and protected against dynamic effects (e.g., missiles, pipe whip, and jet impingement), respectively.

2. General Design Criterion 16 as it relates to a system, in concert with the reactor containment, being provided to establish an essentially leak tight barrier against the uncontrolled release of radioactivity to the environment.

3. General Design Criterion 54, as it relates to piping systems penetrating the containment being provided with leak detection, isolation, and containment capabilities having redundant and reliable performance capabilities, and as it relates to design provision incorporated to permit periodic operability testing of the containment isolation system, and leak rate testing of isolation valves.

4. General Design Criteria 55 and 56 as it relates to lines that penetrate the primary containment boundary and either are part of the reactor coolant pressure boundary or connect directly to the containment atmosphere being provided with isolation valves as follows:

    a. One locked closed isolation valve[1] inside and one locked closed isolation valve outside containment; or

    b. One automatic isolation valve inside and one locked closed isolation valve outside containment; or

    c. One locked closed isolation valve inside and one automatic isolation valve[2] outside containment; or

    d. One automatic isolation valve inside and one automatic isolation valve[2] outside containment.

5. General Design Criterion 57 as it relates to lines that penetrate the primary containment boundary and are neither part of the reactor coolant pressure boundary nor connected directly to the containment atmosphere being provided with at least one locked closed, remote-manual, or automatic isolation valve[2] outside containment.

[1]Locked closed isolation valves are defined as sealed closed barriers (see Item II.3.f).

[2]A simple check valve is not normally an acceptable automatic isolation valve for this application.

6. Appendix K to 10 CFR Part 50 as it relates to the determination of the extent of fuel failure (source term) used in the radiological calculations.

The General Design Criteria identified above established requirements for the design, testing, and functional performance of isolation barriers in lines penetrating the primary containment boundary and, in general, required that two isolation in series be used to assure that the isolation function is maintained assuming any single active failure in the containment isolation provisions. However, containment isolation provisions that differ from the explicit requirements of General Design Criteria 55 and 56 are acceptable if the basis for the difference is justified.

Specific criteria necessary to meet the relevant requirements of the regulations identified above and guidelines for acceptable alternate containment isolation provisions for certain classes of lines are as follows:

a. Regulatory Guide 1.11 describes acceptable containment isolation provisions for instrument lines. In addition, instrument lines that are closed both inside and outside containment, are designed to withstand the pressure and temperature conditions following a loss-of-coolant accident, and are designed to withstand dynamic effects, are acceptable without isolation valves.

b. Containment isolation provisions for lines in engineered safety feature or engineered safety feature-related systems may include remote-manual valves, but provisions should be made to detect possible leakage from these lines outside containment.

c. Containment isolation provisions for lines in systems needed for safe shutdown of the plant (e.g., liquid poison system, reactor core isolation cooling system, and isolation condenser system) may include remote-manual valves, but provisions should be made to detect possible leakage from these lines outside containment.

d. Containment isolation provisions for lines in the systems identified in items b and c normally consist of one isolation valve inside, and one isolation valve outside containment. If it is not practical to locate a valve inside containment (for example, the valve may be under water as a result of an accident), both valves may be located outside containment. For this type of isolation valve arrangement, the valve nearest the containment and the piping between the containment and the valve should be enclosed in a leak-tight or controlled leakage housing. If, in lieu of a housing, conservative design of the piping and valve is assumed to preclude a breach of piping integrity, the design should conform to the requirements of SRP Section 3.6.2. Design of the valve and/or the piping compartment should provide the capability to detect leakage from the valve shaft and/or bonnet seals and terminate the leakage.

e. Containment isolation provisions for lines in engineered safety feature or engineered safety feature-related systems normally consist of two isolation valves in series. A single isolation valve will be acceptable if it can be shown that the system reliability is greater with only one isolation valve in the line, the system is closed outside containment, and a single active failure can be accommodated with only one isolation valve in the line. The closed system outside containment should be protected from missiles, designed to seismic Category I standards, classified Safety

Class 2 (Ref. 9), and should have a design temperature and pressure rating at least equal to that for the containment. The closed system outside containment should be leak tested, unless it can be shown that the system integrity is being maintained during normal plant operations. For this type of isolation valve arrangement the valve is located outside containment, and the piping between the containment and the valve should be enclosed in a leak tight or controlled leakage housing. If, in lieu of a housing, conservative design of the piping and valve is assumed to preclude a breach of piping integrity, the design should conform to the requirements of SRP Section 3.6.2. Design of the valve and/or the piping compartment should provide the capability to detect leakage from the valve shaft and/or bonnet seals and terminate the leakage.

f. Sealed closed barriers may be used in place of automatic isolation valves. Sealed closed barriers include blind flanges and sealed closed isolation valves which may be closed manual valves, closed remote-manual valves, and closed automatic valves which remain closed after a loss-of-coolant accident. Sealed closed isolation valves should be under administrative control to assure that they cannot be inadvertently opened. Administrative control includes mechanical devices to seal or lock the valve closed, or to prevent power from being supplied to the valve operator.

g. Relief valves may be used as isolation valves provided the relief setpoint is greater than 1.5 times the containment design pressure.

h. Item II.E.4.2 of NUREG-0737 and NUREG-0718 requires that systems penetrating the containment be classified as either essential or nonessential. Regulatory Guide 1.141 will contain guidance on the classification of essential and nonessential systems. Essential systems, such as those described in items b and c, may include remote-manual containment isolation valves, but provisions should be made to detect possible leakage from the lines outside containment. Item II.E.4.2 of NUREG-0737 and NUREG-0718 also requires that nonessential systems be automatically isolated by the containment isolation signal.

i. Isolation valves outside contaiment should be located as close to the containment as practical, as required by General Design Criteria 55, 56, and 57.

j. In meeting the requirements of General Design Criteria 55 and 56, upon loss of actuating power, automatic isolation valves should take the position that provides greater safety. The position of an isolation valve for normal and shutdown plant operating conditions and postaccident conditions depends on the fluid system function. If a fluid system does not have a postaccident function, the isolation valves in the lines should be automatically closed. For engineered safety features or engineered safety feature-related systems, isolation valves in the lines may remain open or be opened. The position of an isolation valve in the event of power failure to the valve operator should be the "safe" position. Normally this position would be the postaccident valve position. For lines equipped with motor-operated valves, a loss of actuating power will leave the affected valve in the "as is" position, which may be the open position; however, redundant isolation barriers assure that the isolation function for the line is satisfied. All power operated isolation valves should have position indication in the main control room.

k. To improve the reliability of the isolation function, which is addressed in General Design Criterion 54, Item II.E.4.2 of NUREG-0737 and NUREG-0718 requires that the containment setpoint pressure that initiates containment isolation for nonessential penetrations be reduced to the minimum value compatible with normal operating conditions.

l. There should be diversity in the parameters sensed for the initiation of containment isolation to satisfy the requirement of General Design Criterion 54 for reliable isolation capability.

m. To improve the reliability of the isolation function, which is addressed in General Design Criterion 54, system lines which provide an open path from the containment to the environs (e.g., purge and vent lines which are addressed in Item II.E.4.2 of NUREG-0737 and NUREG-0718) should be equipped with radiation monitors that are capable of isolating these lines upon a high radiation signal. A high radiation signal should not be considered one of the diverse containment isolation parameters.

n. In meeting the requirements of General Design Criterion 54 the performance capability of the isolation function should reflect the importance to safety of isolating system lines. Consequently, containment isolation valve closure times should be selected to assure rapid isolation of the containment following postulated accidents. The valve closure time is the time it takes for a power operated valve to be in the fully closed position after the actuator power has reached the operator assembly; it does not include the time to reach actuation signal setpoints or instrument delay times, which should be considered in determining the overall time to close a valve. System design capabilities should be considered in establishing valve closure times. For lines which provide an open path from the contaiment to the environs; e.g., the containment purge and vent lines, isolation valve closure times on the order of 5 seconds or less may be necessary. The closure times of these valves should be established on the basis of minimizing the release of containment atmosphere to the environs, to mitigate the offsite radiological consequences, and assure that emergency core cooling system (ECCS) effectiveness is not degraded by a reduction in the containment backpressure. Analyses of the radiological consequences and the effect on the containment backpressure due to the release of containment atmosphere should be provided to justify the selected valve closure time. Additional guidance on the design and use of containment purge systems which may be used during the normal plant operating modes (i.e., startup, power operation, hot standby and hot shutdown) is provided in Branch Technical Position CSB 6-4 (Ref. 13). For plants under review for operating licenses or plants for which the Safety Evaluation Report for construction permit application was issued prior to July 1, 1975, the methods described in Section B, Items B.1.a, b, d, e, g, f, and g, B.2 through B.4, and B.5.b, c, and d of Branch Technical Position CSB 6-4 should be implemented. For these plants, BTP Items B.1.c and B.5.a, regarding the size of the purge system used during normal plant operation and the justification by acceptable dose consequence analysis, may be waived if the applicant commits to limit the use of the purge system to less than 90 hours per year while the plant is in the startup, power, hot standby and hot shutdown modes of operations. This commitment should be incorporated into the Technical Specifications used in the operation of the plant.

Item II.E.4.2 of NUREG-0737 and NUREG-0718 requires that containment purge valves that do not satisfy the operability criteria set forth in Branch Technical Position CSB 6-4 or the Staff Interim Position of October 23, 1979 must be sealed closed as defined in SRP Section 6.2.4, Item II.3.f during operational conditions 1, 2, 3 and 4. Furthermore, these valves must be verified to be closed at least every 31 days. (A copy of the Staff Interim Position appears as Attachment 1 to Item II.E.4.2 in NUREG-0737.)

o. The use of a closed system inside containment as one of the isolation barriers will be acceptable if the design of the closed system satisfies the following requirements:

1. The system does not communicate with either the reactor coolant system or the containment atmosphere.

2. The system is protected against missiles and pipe whip.

3. The system is designated seismic Category I.

4. The system is classified Safety Class 2 (Ref. 12).

5. The system is designed to withstand temperatures at least equal to the containment design temperature.

6. The system is designed to withstand the external pressure from the containment structure acceptance test.

7. The system is designed to withstand the loss-of-coolant accident transient and environment.

Insofar as CSB is concerned with the structural design of containment internal structures and piping systems, the protection of isolation barriers against loss of function from missiles, pipe whip, and earthquakes will be acceptable if isolation barriers are located behind missiles barriers, pipe whip was considered in the design of pipe restraints and the location of piping penetrating the containment, and the isolation barriers, including the piping between isolation valves, are designated seismic Category I, i.e., designed to withstand the effects of the safe shutdown earthquake, as recommended by Regulatory Guide 1.29.

p. In meeting the requirements of General Design Criteria 1, 2, 4 and 54, appropriate reliability and performance considerations should be included in the design of isolation barriers to reflect the importance to safety of assuring their integrity; i.e., containment capability, under accident conditions. The design criteria applied to components performing a containment isolation function, including the isolation barriers and the piping between them, or the piping between the containment and the outermost isolation barrier, are acceptable if:

1. Group B quality standards, as defined in Regulatory Guide 1.26 are applied to the components, unless the service function dictates that Group A quality standards be applied.

2. The components are designated seismic Category I, in accordance with Regulatory Guide 1.29.

q. General Design Criterion 54 requires reliable isolation capability. Therefore, when considering remote manual isolation valves, the design of the containment isolation system is acceptable if provisions are made to allow the operator in the main control room to know when to isolate fluid systems that are equipped with remote manual isolation valves. Such provisions may include instruments to measure flow rate, sump water level, temperature, pressure, and radiation level.

r. General Design Criterion 54 specifies the requirements for the containment isolation system. Therefore, to satisfy General Design Criterion 54, provisions should be made in the design of the containment isolation system for operability testing of the containment isolation valves and leakage rate testing of the isolation barriers. The isolation valve testing program should be consistent with that proposed for other engineered safety features. The acceptance criteria for the leakage rate testing program for containment isolation barriers are presented in SRP Section 6.2.6.

s. General Design Criterion 54 requires reliable isolation capability. To satisfy this requirement, provisions should be made in the design of the containment isolation system to reduce the possibility of isolation valves reopening inadvertently following isolation. In this regard, Item II.E.4.2 of NUREG-0737 and NUREG-0718 requires that the design of the control systems for automatic containment isolation valves be such that resetting the isolation signal will not result in the automatic reopening of containment isolation valves. Reopening of containment isolation valves should require deliberate operator action. In addition, ganged reopening of containment isolation valves is not acceptable. Reopening of isolation valves must be performed on a valve-by-valve basis, or on a line-by-line basis, provided that electrical independence and other single-failure criterion continue to be satisfied.

   Administrative provisions to close all isolation valves manually before resetting the isolation signals is not an acceptable method of meeting this design requirement.

III. REVIEW PROCEDURES

The procedures described below provide guidance on review of the containment isolation system. The reviewer selects and emphasizes material from the review procedures as may be appropriate for a particular case. Portions of the review may be done on a generic basis for aspects of containment isolation common to a class of containments, or by adopting the results of previous reviews of plants with essentially the same containment isolation provisions.

Upon request from the primary reviewer, other 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.

The CSB determines the acceptability of the containment isolation system by comparing the system design criteria to the design requirements for an engineered safety feature. The quality standards and the seismic design classification of the containment isolation provisions including the piping penetrating the containment, are compared to Regulatory Guides 1.26 and 1.29, respectively.

The CSB also ascertains that no single fault can prevent isolation of the containment. This is accomplished by reviewing the containment isolation provisions for each line penetrating the containment to determine that two isolation barriers in series are provided, and in conjunction with the PSB by reviewing the power sources to the valve operators.

The CSB reviews the information in the SAR justifying containment isolation provisions which differ from the explicit requirements of General Design Criteria 55, 56, and 57. The CSB judges the acceptability of these containment isolation provisions based on a comparison with the acceptance criteria given in subsection II of this SRP section.

The CSB reviews the position of isolation valves for normal and shutdown plant operating conditions, postaccident conditions, and valve operator power failure conditions as listed in the SAR. The position of an isolation valve for each of the above conditions depends on the system function. In general, power-operated valves in fluid systems which do not have a postaccident safety function (nonessential systems, as defined in Regulatory Guide 1.141) should close automatically. In the event of power failure to a valve operator, the valve position should be the position of greater safety, which is normally the postaccident position. However, special cases may arise and these will be considered on an individual basis in determining the acceptability of the prescribed valve positions. The CSB also ascertains from the SAR that all power-operated isolation valves have position indication capability in the main control room.

The CSB reviews the signals obtained from the plant protection system to initiate containment isolation. In general, there should be a diversity of parameters sensed; e.g., abnormal conditions in the reactor coolant system, the secondary coolant system, and the containment, which generate containment isolation signals. Since plant designs differ in this regard and many different combinations of signals from the plant protection system are used to initiate containment isolation, the CSB considers the arrangement proposed on an individual basis in determining the overall acceptability of the containment isolation signals. The CSB will use the guidance presented in Item II.E.4.2 of NUREG-0737 for its review of the containment setpoint pressure that initiates containment isolation for nonessential penetrations. This pressure setpoint should be the minimum value that is compatible with normal operating conditions.

The CSB reviews isolation valve closure times. In general, valve closure times should be less than one minute, regardless of valve size. (See the acceptance criteria for valve closure times in subsection II of this SRP section.) Valves in lines that provide a direct path to the environs, e.g., the containment purge and ventilation system lines and main steam lines for direct cycle plants, may have to close in times much shorter than one minute. Closure times for these valves may be dictated by radiological dose analyses or ECCS performance considerations. The CSB will request the AEB or RSB to review analyses justifying valve closure times for these valves as necessary.

The CSB determines the acceptability of the use of closed systems inside containment as isolation barriers by comparing the system designs to the acceptance criteria specified in subsection II of this SRP section.

The MEB and SEB have review responsibility for the structural design of the containment internal structures and piping systems, including restraints, to assure that the containment isolation provisions are adequately protected against missiles, pipe whip, and earthquakes. The CSB determines that for all containment isolation provisions, missile protection and protection against loss of function from pipe whip and earthquakes were design considerations. The CSB reviews the system drawings (which should show the locations of missile barriers relative to the containment isolation provisions) to determine that the isolation provisions are protected from missiles. The CSB also reviews the design criteria applied to the containment isolation provisions to determine that protection against dynamic effects, such as pipe whip and earthquakes, was considered in the design. The CSB will request the MEB to review the design adequacy of piping and valves for which conservative design is assumed to preclude possible breach of system integrity in lieu of providing a leak tight housing.

Systems having a postaccident safety function (essential systems, as defined in Regulatory Guide 1.141) may have remote-manual isolation valves in the lines penetrating the containment. The CSB reviews the provisions made to detect leakage from these lines outside containment and to allow the operator in the main control room to isolate the system train should leakage occur. Leakage detection provisions may include instrumentation for measuring system flow rates, or the pressure, temperature, radiation, or water level in areas outside the containment such as valve rooms or engineered safeguards areas. The CSB bases its acceptance of the leakage detection provisions described in the SAR on the capability to detect leakage and identify the lines that should be isolated.

The CSB determines that the containment isolation provisions are designed to allow the isolation barriers to be individually leak tested. This information should be tabulated in the safety analysis report to facilitate the CSB review.

The CSB determines from the descriptive information in the SAR that provisions have been made in the design of the containment isolation system to allow periodic operability testing of the power-operated isolation valves and the containment isolation system. At the operating license stage of review, the CSB determines that the content and intent of proposed technical specifications pertaining to operability and leak testing of containment isolation equipment is in agreement with requirements developed by the staff.

The CSB verifies that the design of the control system for automatic containment isolation valves is such that resetting the isolation signal will not result in the automatic reopening of containment isolation valves, and that ganged reopening of isolation valves is not possible.

IV. EVALUATION FINDINGS

The information provided and the CSB review should support concluding statements similar to the following, to be included in the staff's safety evaluation report:

> The staff concludes that the containment functional design is acceptable and meets the requirements of General Design Criteria 1, 2, 4, 16, 54, 55, 56, and 57 and Appendix K to 10 CFR Part 50. The conclusion is based on the following: [The reviewer should discuss each item of the regulations or related set of regulations as indicated.]
>
> 1. The applicant has met the requirements of (cite regulation) with respect to (state limits of review in relation to regulation)

by (for each item that is applicable to the review state how it was met and why acceptable with respect to the regulation being discussed):

a. meeting the regulatory positions in NUREG ______ and/or Regulatory Guide(s) ____;

b. providing and meeting an alternative method to regulatory positions in Regulatory Guide _____, that the staff has reviewed and found to be acceptable;

c. meeting the regulatory position in BTP_______;

d. using calculational methods for (state what was evaluated) that have been previously reviewed by the staff and found acceptable; the staff has reviewed the impact parameters in this case and found them to be suitably conservative or performed independent calculations to verify acceptability of their analysis; and/or

e. meeting the provisions of (industry standard number and title) that have been reviewed by the staff and determined to be appropriate for this application.

2. Repeat discussion for each regulation cited above.

V. IMPLEMENTATION

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

Except in those cases in which the applicant proposes as 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, Appendix A, General Design Criterion 1, "Quality Standards and Records."

2. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

3. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Basis."

4. 10 CFR Part 50, Appendix A, General Design Criterion 16, "Containment Design."

5. 10 CFR Part 50, Appendix A, General Design Criterion 54, "Piping Systems Penetrating Containment."

6. 10 CFR Part 50, Appendix A, General Design Criterion 55, "Reactor Coolant Pressure Boundary Penetrating Containment."

7. 10 CFR Part 50, Appendix A, General Design Criterion 56, "Primary Containment Isolation."

8. 10 CFR Part 50, Appendix A, General Design Criterion 57, "Closed System Isolation Valves."

9. Regulatory Guide 1.11, "Instrument Lines Penetrating Primary Reactor Containment."

10. Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants."

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

12. Regulatory Guide 1.141, "Containment Isolation Provisions for Fluid Systems."

13. Branch Technical Position CSB 6-4, "Containment Purging During Normal Plant Operation," attached to this SRP section.

14. 10 CFR Part 100, "Reactor Site Criteria."

15. 10 CFR Part 50, Appendix K, "ECCS Evaluation Models."

16. NUREG-0737, "Classifications of TMI Action Plan Requirements."

17. NUREG-0718, "Licensing Requirements for Pending Application for Construction Permits and Manufacturing License."

Branch Technical Position CSB 6-4

CONTAINMENT PURGING DURING NORMAL PLANT OPERATIONS

A. BACKGROUND

This branch technical position pertains to system lines which can provide an open path from the containment to the environs during normal plant operation; e.g., the lines associated with the containment purge and vent systems. It supplements the position taken in SRP Section 6.2.4.

While the containment purge and vent systems provide plant operational flexibility, their designs must consider the importance of minimizing the release of containment atmosphere to the environs following a postulated loss-of-coolant accident. Therefore, plant designs must not rely on their use on a routine basis.

The need for purging has not always been anticipated in the design of plants, and therefore, design criteria for the containment purge system have not been fully developed. The purging experience at operating plants varies considerably from plant to plant. Some plants do not purge during reactor operation, some purge intermittently for short periods and some purge continuously. There is similar disparity in the need for, and use of, containment vent systems at operating plants.

Containment purge systems have been used in a variety of ways; for example, to alleviate certain operational problems, such as excess air leakage into the containment from pneumatic controllers, for reducing the airborne activity within the containment to facilitate personnel access during reactor power operation, and for controlling the containment pressure, temperature and relative humidity. Containment vent systems are typically used to relieve the initial containment pressure buildup caused by the heat load imposed on the containment atmosphere during reactor power ascension, or to periodically relieve the pressure buildup due to the operation of pneumatic controllers. However, the purge and vent lines provide an open path from the contaiment to the environs. Should a LOCA occur during containment purging when the reactor is at power, the calculated accident doses should be within 10 CFR Part 100 guidelines values.

The sizing of the purge lines in most plants have been based on the need to control the containment atmosphere during refueling operations. This need has resulted in very large lines penetrating the containment (about 42 inches in diameter). Since these lines are normally the only ones provided that will permit some degree of control over the containment atmosphere to facilitate personnel access, some plants have used them for containment purging during normal plant operation. Under such conditions, calculated accident doses could be significant. Therefore, the use of these large containment purge and vent lines should be restricted to cold shutdown conditions and refueling operations and they must be sealed closed in all other operational modes.

The design and use of the purge and vent lines should be based on the premise of achieving acceptable calculated offsite radiological consequences and assuring that emergency core cooling (ECCS) effectiveness is not degraded by a reduction in the contaiment backpressure.

Purge system designs that are acceptable for use on a nonroutine basis during normal plant operation can be achieved by providing additional purge lines.

The size of these lines should be limited such that in the event of a loss-of-coolant accident, assuming the purge valves are open and subsequently close, the radiological consequences calculated in accordance with Regulatory Guides 1.3 and 1.4 would not exceed the 10 CFR Part 100 guideline values. Also, the maximum time for valve closure should not exceed five seconds to assure that the purge valves would be closed before the onset of fuel failures following a LOCA. Similar concerns apply to vent system designs.

The size of the purge lines should be about eight inches in diameter for PWR plants. This line size may be overly conservative from a radiological viewpoint for the Mark III BWR plants and the HTGR plants because of containment and/or core design features. Therefore, larger line sizes may be justified. However, for any proposed line size, the applicant must demonstrate that the radiological consequences following a loss-of-coolant accident would be within 10 CFR Part 100 guideline values. In summary, the acceptability of a specific line size is a function of the site meteorology, containment design, and radiological source term for the reactor type; e.g., BWR, PWR, or HTGR.

B. BRANCH TECHNICAL POSITION

The systems used to purge the containment for the reactor operational modes of power operation, startup, hot standby and hot shutdown; i.e., the on-line purge system, should be independent of the purge system used for the reactor operational modes of cold shutdown and refueling.

1. The on-line purge system should be designed in accordance with the following criteria:

   a. General Design Criterion 54 requires that the reliability and performance capabilities of containment isolation valves reflect the importance of safety of isolating the systems penetrating the containment boundary. Therefore, the performance and reliability of the purge system isolation valves should be consistent with the operability assurance program outlined in Branch Technical Position MEB-2, "Pump and Valve Operability Assurance Program." (Also see SRP Section 3.10.) The design basis for the valves and actuators should include the buildup of containment pressure for the LOCA break spectrum, and the supply line and exhaust line flows as a function of time up to and during valve closure.

   b. The number of supply and exhaust lines that may be used should be limited to one supply line and one exhaust line, to improve the reliability of the isolation function as required by General Design Criterion 54, and to facilitate compliance with the requirements of Appendix K to 10 CFR Part 50 regarding the containment pressure used in the evaluation of the emergency core cooling system effectiveness and 10 CFR Part 100 regarding offsite radiological consequences.

   c. The size of the lines should not exceed about eight inches in diameter, unless detailed justification for larger line sizes is provided, to improve the reliability and performance capability of the isolation and containment functions as required by General Design Criterion 54, and to facilitate compliance with the requirements of Appendix K to 10 CFR Part 50 regarding the containment pressure used in evaluating the emergency core cooling system effectiveness and 10 CFR Part 100 regarding the offsite radiological consequences.

d. As required by General Design Criterion 54, the containment isolation provisions for the purge system lines should meet the standards appropriate to engineered safety features; i.e., quality, redundancy, testability and other appropriate criteria, to reflect the importance to safety of isolating these lines. General Design Criterion 56 establishes explicit requirements for isolation barriers in purge system lines.

e. To improve the reliability of the isolation function, which is addressed in General Design Criterion 54, instrumentation and control systems provided to isolate the purge system lines should be independent and actuated by diverse parameters; e.g., containment pressure, safety injection actuation, and containment radiation level. Furthermore, if energy is required to close the valves, at least two diverse sources of energy shall be provided, either of which can effect the isolation function.

f. Purge system isolation valve closure times, including instrumentation delays, should not exceed five seconds, to facilitate compliance with 10 CFR Part 100 regarding offsite radiological consequences.

g. Provisions should be made to ensure that isolation valve closure will not be prevented by debris which could potentially become entrained in the escaping air and steam.

2. The purge system should not be relied on for temperature and humidity control within the containment.

3. Provisions should be made to minimize the need for purging of the containment by providing containment atmosphere cleanup systems within the containment.

4. Provisions should be made for testing the availability of the isolation function and the leakage rate of the isolation valves during reactor operation.

5. The following analyses should be performed to justify the containment purge system design:

a. An analysis of the radiological consequences of a loss-of-coolant accident. The analysis should be done for a spectrum of break sizes, and the instrumentation and setpoints that will actuate the purge valves closed should be identified. The source term used in the radiological calculations should be based on a calculation under the terms of Appendix K to determine the extent of fuel failure and the concomitant release of fission products, and the fission product activity in the primary coolant. A pre-existing iodine spike should be considered in determining primary coolant activity. The volume of containment in which fission products are mixed should be justified, and the fission products from the above sources should be assumed to be released through the open purge valves during the maximum interval required for valve closure. The radiological consequences should be within 10 CFR Part 100 guideline values.

b. An analysis which demonstrates the acceptability of the provisions made to protect structures and safety-related equipment; e.g., fans, filters, and ductwork, located beyond the purge system isolation valves against loss of function from the environment created by the escaping air and steam.

c. An analysis of the reduction in the containment pressure resulting from the partial loss of containment atmosphere during the accident for ECCS backpressure determination.

d. The maximum allowable leak rate of the purge isolation valves should be specified on a case-by-case basis giving appropriate consideration to valve size, maximum allowable leakage rate for the containment (as defined in Appendix J to 10 CFR Part 50), and where appropriate, the maximum allowable bypass leakage fraction for dual containments.