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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 79 – Containment Isolation Function – RAI Numbers 6.2-104 through 6.2-117, 6.2-123, 6.2-124, 6.2-126, 6.2-128, and 6.2-129**

Enclosure 1 contains GE's response to the subject NRC RAIs transmitted via the Reference 1 letter.

If you have any questions about the information provided here, please let me know.

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-393, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 71 Related to ESBWR Design Certification Application*, October 11, 2006

Enclosure:

1. MFN 06-461 – Response to Portion of NRC Request for Additional Information Letter No. 79 – Containment Isolation Function – RAI Numbers 6.2-104 through 6.2-117, 6.2-123, 6.2-124, 6.2-126, 6.2-128, and 6.2-129

cc: AE Cubbage USNRC (with enclosures)
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eDRF 0060-7635

Enclosure 1

MFN 06-461

Response to Portion of NRC Request for

Additional Information Letter No. 79

Related to ESBWR Design Certification Application

Containment Isolation Function

RAI Numbers 6.2-104 through 6.2-117, 6.2-123, 6.2-124, 6.2-126, 6.2-128, and 6.2-129

NRC RAI 6.2-104

DCD Section 6.2.4, 2nd paragraph, states that the plant meets the relevant requirements of various GDC for containment isolation design. The staff questions three points of the discussion:

(A) The 4th bullet quotes specific, detailed provisions from GDC 55 and 56 for number, position, and type of CIVs required per line, as follows:

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

However, despite this detail, the 3rd and 4th items are missing the sentences in the GDC that say that a simple check valve may not be used as the automatic isolation valve outside containment.

Detailed requirements reproduced from the regulations should not mislead the reader by leaving out significant restrictions. Provide a DCD revision which corrects this problem.

(B) Contrary to the statement that the plant meets the relevant requirements of various GDC, at least four systems do not meet the specific requirements of GDC 55 and 56 listed in the 4th bullet. DCD Tier 2, Revision 1, Table 1.9-6 lists three of them, and the 4th is the PCCS. Clarify or correct this apparent discrepancy.

(C) The 5th bullet, addressing GDC 57, has the same problem as the 4th bullet in that it does not say that a simple check valve may not be used as the automatic isolation valve. Provide a DCD revision which corrects this problem.

GE Response

(A) In Revision 3 to DCD Tier 2, Subsection 6.2.4, fourth bullet text will be revised to be consistent with 10 CFR 50 Appendix A, GDC 55 and 56 as noted on the attached markup.

(B) Please refer to response to RAI 6.2-102; no DCD changes will be made in response to this item.

(C) In Revision 3 to DCD Tier 2, Subsection 6.2.4, fifth bullet text will be revised to be consistent with 10 CFR 50 Appendix A, GDC 57 as noted on the attached markup.

NRC RAI 6.2-105

In DCD Tier 2, Revision 1, Section 6.2.4.1, "Design Bases," under the heading "Safety Design Bases," the 2nd bullet should be clarified: "Capability for rapid closure or isolation of all pipes or ducts that penetrate the containment ***is performed means or devices*** *to limit leakage within permissible limits."*

GE Response

DCD Tier 2, Section 6.2.4.1, under heading "Safety Design Bases", second bullet will be corrected in DCD Tier 2, Revision 3 as noted on the attached markup.

NRC RAI 6.2-106

In DCD Tier 2, Revision 1, Section 6.2.4.1, "Design Bases," under the heading "Safety Design Bases," the 3rd bullet states: "The design of isolation valves for lines penetrating the containment follows the requirements of General Design Criteria 54 through 57 ***to the greatest extent practicable consistent with safety and reliability.****" [emphasis added]. The staff does not understand the intent of the highlighted phrase.*

Are you suggesting that an exemption is needed for this regulation? If not, please address how the ESBWR design is in full compliance with these regulations.

GE Response

The only exemptions taken are to GDC 55 and 56 and are mentioned in DCD Tier 2, Chapter 1, Table 1.9-6 "Summary of Differences from SRP Section 6". In DCD, Tier 2, Revision 3, Subsection 6.2.4.1, entitled "Safety Design Bases", third bullet, the reference to Table 1.9-6 for exemptions will be reflected as noted on the attached markup.

NRC RAI 6.2-107

In DCD Tier 2, Revision 1, Section 6.2.4.1, "Design Bases," under the heading "Safety Design Bases," the 7th bullet states:

> *Containment isolation valves and associated piping and penetrations meet the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Class 1, 2, or MC, in accordance with their quality group classification.*

The approved guidance documents (SRP 6.2.4, Rev. 2, RG 1.141, and ANS-56.2/ANSI N271-1976) say that these components must be Class 2 or better.

Explain how, and if, Class MC satisfies the guidelines, or revise the design in conformance with the guidelines.

GE Response

Steel components of containment penetrations other than piping penetrations are governed by ASME Section III, Division 1, Class MC, as per DCD Table 3.2-3 and SRP 3.8.2. The statement in the DCD Tier 2, Subsection 6.2.4.1, under heading "Safety Design Bases", seventh bullet refers to the code for the piping (ASME Section III, Class 1 or 2) as well as the steel components (ASME Section III, Class MC) of other than piping penetrations.

No DCD changes will be made in response to this RAI.

NRC RAI 6.2-108

DCD Tier 2, Revision 1, Section 6.2.4.2.1, "Containment Isolation Valve Closure Times," states:

> *Containment isolation valve closure times are established by determining the isolation requirements necessary to keep radiological effects from exceeding guidelines in 10 CFR 100. For system lines, which can provide an open path from the containment to the environment, a discussion of valve closure time bases is provided in Chapter 15.*

This seems to suggest that any (long) closure time is acceptable as long as Part 100 guidelines are met. The staff's philosophy for selecting closure times, as expressed in SRP 6.2.4, Rev. 2, and RG 1.141, is more conservative. ANS-56.2/ANSI N271-1976, which is endorsed by RG 1.141, states in section 4.4.4, "Valve Closure Time," that:

> *The objective in establishing valve closure times should be to limit as low as reasonably attainable the release of radioactivity from the containment...*
>
> *In general, power-operated valves 3-1/2 inches to 12 inches in diameter should be closed at least within a time determined by dividing the nominal valve diameter by 12 inches per minute... Valves 3 inches and less generally close within 15 seconds. This results in small valves closing faster than large valves. All valves larger than 12 inches in diameter should close within one minute unless an accident radiation dose calculation is performed to show that the longer closure time does not result in a significant increase in off-site dose.*
>
> *Shorter valve closure times may be required for purge, vent, or other valves which may be open during plant operation and which provide an open path from the containment atmosphere to the environment outside the containment...*

Provide a discussion which justifies the ESBWR approach (doses not exceeding Part 100 guidelines) when compared to the staff and industry standard position (doses as low as reasonably attainable). Alternately, revise the DCD to be consistent with the staff and industry standard position.

GE Response

In Revision 3 to DCD Tier 2, Subsection 6.2.4.2.1, as noted on the attached markup, will include the valve closing time to be consistent with the industry standards.

NRC RAI 6.2-109

In the tables of CIVs (DCD Tier 2, Revision 1, Tables 6.2-16 through 6.2-42 and 6.2-47), for the entries for valve closure times, times are listed, but footnotes say "Closing Times are estimates and will be confirmed during detailed design stage." DCD Tier 2, Revision 1,Section 6.2.8.4, "Containment Isolation Valve Information," states "The COL Applicant shall provide the missing information indicated in Tables 6.2-16 through 6.2-42 and 6.2-47."

Is it intended for the statement in Section 6.2.8.4 to include the closure times? If so, 6.2.8.4 should be clarified because the closure times are not exactly missing from the tables. If not, what is the meaning of the footnotes as to when the closure times will be confirmed; in other words, when is the "detailed design stage"? Is this intended to be a COL action item, ITAAC or both?

GE Response

Closure times and other missing information in Tables 6.2-31a, 33, 34 and 35 will be provided in DCD Tier 2, Revision 3. The statements "* Closing Times are estimates and will be confirmed during detailed design stage" and "* Closing Times will be confirmed during detailed design stage." are being deleted from all Chapter 6 Tables wherever they exist.

Subsection 6.2.8.4 will be deleted in Revision 3 of DCD. Tables 6.2-23 through 6.2-31a and 6.2-33 through 6.2-35 will be revised as noted on the attached markup.

NRC RAI 6.2-110

(A) DCD Tier 2, Revision 1, Section 6.2.4.2.2, "Instrument Lines Penetrating Containment," and Section 6.2.4.3.2.5, "Evaluation Against Regulatory Guide 1.11," state that sensing instrument lines penetrating the containment follow all the recommendations of RG 1.11 ,in that each line has a 1/4-inch orifice inside the containment and a manually-operated isolation valve just outside the containment.

This design does not conform to the guidelines of RG 1.11. RG 1.11, section C., "Regulatory Position," Subsection 1.c., states that the lines:

Should be provided with an isolation valve capable of automatic operation or remote operation from the control room or from another appropriate location...

In addition, there are other parts of the regulatory position which the DCD does not address, such as C.1.a., C.1.d., and C.1.e., and other details in C.1.c. and C.1.b. (orifice) which are also not addressed. Revise the DCD to provide a complete discussion which justifies the claim that the design follows all the recommendations of RG 1.11.

(B) Apparently no instrument lines are listed or described in the DCD tables of CIVs (DCD Tier 2, Revision 1, Tables 6.2-16 through 6.2-42 and 6.2-47). Identify and describe all instrument lines penetrating containment in the DCD tables of CIVs.

GE Response

(A) Instrument lines penetrating primary containment meet RG 1.11 by having an excess flow check valve in each line following the manually-operated isolation valve as discussed in the Section B of the regulatory guide. Each instrument line also meets the conditions described in the second and third paragraphs of Section B of RG 1.11. Each instrument line is provided with a flow restriction orifice, acceptability of instrument response times with the presence of the orifice, and assurance that the flow restriction is not plugged. With these condition met, this regulatory guide allows a self-actuated excess flow check valve as an automatically operated valve.

DCD Tier 2, Subsection 6.2.4.2.2, first sentence states "Sensing instrument lines penetrating the containment follow all the recommendations of Regulatory Guide 1.11" currently addresses all regulatory positions including C.1.a through C.1.e of RG 1.11.

(B) A separate Table will be added in the DCD Tier 2, Revision 3 that will identify all the instrument lines penetrating the primary containment.

DCD Impact

(A) The changes to DCD Tier 2, Section 6.2.4.2.2, will be reflected in Revision 3 to the DCD Tier 2, as noted in the attached markup.

(B) A Table will be added identifying all instrument lines penetrating containment in DCD Tier 2 Revision 3.

NRC RAI 6.2-111

DCD Tier 2, Revision 1, Section 6.2.4.2.3, "Compliance with General Design Criteria and Regulatory Guides," states, in part:

> *In general, all requirements of General Design Criteria 54, 55, 56, and Regulatory Guide 1.11 are met in the design of the containment isolation function.*

Why were GDC 57 and RG 1.141 not addressed as part of this statement?

GE Response

DCD Tier 2, Subsections 6.2.4.2.3, 6.2.4.3.2.4 and Table 6.2-33 will be revised by addressing GDC 57 and RG 1.141 design requirements, as noted on the attached markup.

<u>NRC RAI 6.2-112</u>

DCD Tier 2, Revision 1, Section 6.2.4.2.4, "Operability Assurance, Codes and Standards, and Valve Qualification and Testing," states, in part:

> *The containment isolation function piping and valves are designed in accordance with Seismic Category I requirements as defined in Section 3.7 using the techniques of Subsection 3.9.3.2.*

The staff's position (SRP 6.2.4, Rev. 2, and RG 1.141) is simply that they be designed in accordance with Seismic Category I requirements. The staff could infer from the qualifiers, "as defined in Section 3.7 using the techniques of Subsection 3.9.3.2," that the simpler statement would not be correct. Ultimately, the design either does or does not conform to Seismic Category I requirements. Please explain.

<u>GE Response</u>

The containment isolation function piping and valves are designed in accordance with Seismic Category I requirements as per SRP 6.2.4, Revision 2, and RG 1.141. In Revision 3 to DCD Tier 2, Subsection 6.2.4.2.4 the qualifier "as defined in Section 3.7 using the techniques of Subsection 3.9.3.2." will be deleted as noted on the attached markup.

NRC RAI 6.2-113

DCD Tier 2, Revision 1, Section 6.2.4.2.4, "Operability Assurance, Codes and Standards, and Valve Qualification and Testing," states, in part, that DCD Section 3.11 presents a discussion of the environmental conditions for which the CIVs and pipe are designed.

Provide a statement in this DCD Section as to whether the CIVs and associated pipes are designed to withstand the peak calculated temperatures and pressures of postulated accidents to which they would be exposed.

GE Response

A statement will be provided in Revision 3 to the DCD Tier 2 Subsection 6.2.4.2.4, as noted on the attached markup, indicating that the CIVs are designed to withstand the peak calculated temperatures and pressures during postulated design basis accidents to which they would be exposed.

NRC RAI 6.2-114

DCD Tier 2, Revision 1, Section 6.2.4.2.4, "Operability Assurance, Codes and Standards, and Valve Qualification and Testing," states, in part, that the CIVs are designed in accordance with the requirements of ASME Code, Section III. Does this mean that they are designed to safety class 2 requirements? SRP 6.2.4, Rev. 2, section II.p.1, states that components performing a containment isolation function are to meet at least Group B quality standards, as defined in RG 1.26.

Provide a statement in the DCD as to whether these SRP guidelines are met.

GE Response

Containment isolation valves are designed to a minimum Group B quality standard. DCD Table 3.2-1 provides the Quality Group of containment isolation valves for each system. In Revision 3 to DCD Tier 2, Subsection 6.2.4.2.4, as noted on the attached markup, will reflect the Quality Group requirement as per SRP 6.2.4 Revision 2.

NRC RAI 6.2-115

(A) *DCD Tier 2, Revision 1, Section 6.2.4.2.5, "Redundancy and Modes of Valve Actuations," states, in part:*

> *Redundancy is provided in all design aspects to satisfy the requirement that no active failure of a single valve or component prevents containment isolation.*

This is not quite as conservative as the guidelines expressed in SRP 6.2.4, Rev. 2 (section III, 4th paragraph), which is that no single active failure of any kind should prevent containment isolation. An example which illustrates the difference would be a penetration in which both CIVs are motor-operated and both receive emergency power from the same bus. The failure of one of the CIVs would not prevent containment isolation, but the loss of the single emergency bus would.

Provide a discussion or statement in the DCD to indicate whether the ESBWR design meets the more conservative provision of SRP 6.2.4, Rev. 2.

(B) *DCD Tier 2, Revision 1, Section 6.2.4.3.3, "Evaluation of Single Failure," discusses, in general, the principles used to evaluate single failure. It implies that evaluations were performed for the containment isolation system, but does not provide the actual evaluations or even specific conclusions, other than an unsupported statement that "Electrical and mechanical systems are designed to meet the single failure criterion...." It refers to DCD Section 3.1 for more information, but 3.1 only is a general discussion of the ESBWR's compliance with the GDC.*

Provide the actual single failure evaluations performed for the containment isolation system, or at least a better discussion of the evaluations. Address particularly the example given in part 1 of this RAI.

GE Response

(A) In Revision 3 to DCD Tier 2, Subsection 6.2.4.2.5, as noted on the attached markup, the sentence "Redundancy is provided in all design aspects to satisfy the requirement that no active failure of a single valve or component prevents containment isolation" will be revised to "Redundancy is provided in all design aspects to satisfy the requirement that no single active failure of any kind should prevent containment isolation."

(B) Additionally, Subsection 6.2.4.3.3, as noted on the attached markup, will be revised to include statement that each of the power operated containment isolation valve for any given penetration is powered from a different division in order to meet the single failure criteria.

NRC RAI 6.2-116

DCD Tier 2, Revision 1, Section 6.2.4.2.5, "Redundancy and Modes of Valve Actuations," states, in part:

> *Isolation valve arrangements satisfy all requirements specified in General Design Criteria 54, 55, 56 and 57, and Regulatory Guide 1.11.*

The staff notes two problems with this statement:

1. *DCD Tier 2, Revision 1, Table 1.9-6, "Summary of Differences from SRP Section 6," in its entry for SRP 6.2.4, lists several systems for which the containment isolation provisions differ from the GDC requirements (such as having both CIVs inside containment), and there may be more (e.g., PCCS).*
2. *It seems inappropriate to address RG 1.11, which addresses only instrument lines, and not RG 1.141, which addresses all lines.*

Resolve these apparent discrepancies.

GE Response

PCCS is not included in DCD Tier 2 Table 1.9-6 because it does not require containment isolation valves. The reason for not requiring containment isolation valves is that it is designed as an extension to the primary containment. Please see response to RAI 6.2-125.

In Revision 3 to DCD Tier 2, Subsection 6.2.4.2.5, as noted on the attached markup, the following reference to RG 1.141 will be added:

"Isolation valve arrangements satisfy all requirements specified in General Design Criteria 54, 55, 56 and 57, and Regulatory Guides 1.11 and 1.141."

NRC RAI 6.2-117

DCD Tier 2, Revision 1, Section 6.2.4.2.5, "Redundancy and Modes of Valve Actuations," states, in part:

> *Functions for administrative controls and/or locks ensure that the position of all nonpowered isolation valves is maintained and known.*

In the DCD, describe the administrative controls.

GE Response

In Revision 3 to DCD Tier 2, Subsection 6.2.4.2.5, first sentence of the sixth paragraph will be revised explaining administrative controls, as noted on the attached markup.

NRC RAI 6.2-123

DCD Tier 2, Revision 1, Section 6.2.4.3.2.1, "Influent Lines to Containment," under the heading "Containment Inerting System," states that all the CIVs on these lines are outside of the containment to provide accessibility to the valves. This justification is inadequate. SRP 6.2.4, Rev. 2 (section II.d.), RG 1.141, and national standard ANS-56.2/ANSI N271-1976 (sections 3.6.5 and 3.7) provide guidance on acceptable justifications for deviations from the explicit requirements of GDC 55 and 56, including additional requirements when both CIVs are outside containment. Note in particular that the option of having both CIVs outside containment is available only for engineered safety feature (ESF) or ESF-related systems, or systems needed for safe shutdown of the plant.

DCD Tier 2, Revision 1, Section 6.2.4.3.2.2, "Effluent Lines from Containment," under the heading "Containment Inerting System," also contains the same statement.

Provide adequate justification as described.

GE Response

In Revision 3 to DCD Tier 2, Subsection 6.2.4.3.2.1 (as noted on the attached markup) will incorporate the piping design and leak detection requirements as defined in SRP 6.2.4, Revision 2, Section IId, ANS 56.2, Sections 3.6.5 and 3.7, for having both isolation valves outside containment.

NRC RAI 6.2-124

DCD Tier 2, Revision 1, Section 6.2.4.3.2.1, "Influent Lines to Containment," under the heading "High Pressure Nitrogen Supply System," states:

> *Because the pressure in this system is higher than the containment pressure, it is only isolated on low pressure signal inside the High Pressure Nitrogen Supply System.*

The approved guidance is that there should be diversity in the parameters sensed to initiate containment isolation. The high pressure of this system does not relieve it from this guideline. Many of the systems which penetrate containment are high pressure systems; it has no bearing on this issue.

Provide diversity in the parameters sensed to initiate containment isolation of this system, or provide additional justification in the DCD for not doing so.

GE Response

The high pressure nitrogen supply system will be isolated at high drywell pressure or low reactor water level signal. In Revision 3 to DCD Tier 2, Subsection 6.2.4.3.2.1, entitled "Containment Inerting Systems" will reflect the attached markup. Additionally, Table 6.2-40 will reflect the isolation signals.

NRC RAI 6.2-126

DCD Tier 2, Revision 1, Section 6.2.4.3.2.2, "Effluent Lines from Containment," under the heading "Containment Inerting System," states that all of the CIVs are outside containment and that the "piping to both valves is an extension of the containment boundary." This statement does not provide sufficient information.

SRP 6.2.4, Rev. 2, section II.d., states, in part:

> *...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.*

ANS-56.2/ANSI N271-1976, section 3.6.5, "Two Valve Outside Containment," states, in part:

> *The valve nearest the containment wall and piping between the containment and that valve shall be enclosed in a protective leak tight or controlled leakage housing to prevent leakage to the atmosphere. The piping between the two isolation valves shall meet the requirements of 3.7.*

Section 3.7, "Criteria for Piping Outside Containment and Between the Containment and the Isolation Valve(s)," states:

Piping which is outside the containment and is either between the containment and the outside isolation valve or between two outside isolation valves shall:

(1) Meet Safety Class 2 design requirements

(2) Withstand the containment design temperature

(3) Withstand internal pressure from containment structural integrity test

(4) Withstand loss-of-coolant accident transient and environment

(5) Meet Seismic Category I design requirements

(6) Be protected against a high energy line break outside of containment when needed for containment isolation.

Further, the DCD states that the first valve is located as close as practical to the containment. ANS-56.2/ANSI N271-1976, section 3.6.5, states that both valves are to be located as close as practical to the containment.

Provide in the DCD a detailed description of the Containment Inerting System's conformance with these provisions.

GE Response

In Revision 3 to DCD Tier 2, Subsection 6.2.4.3.2.2, as shown on the attached markup, will incorporate the piping design and leak detection requirements defined in SRP 6.2.4 Revision 2, Section IId, ANS 56.2, Sections 3.6.5 and 3.7, for having both isolation valves outside containment.

NRC RAI 6.2-128

Although the containment isolation designs of the Chilled Water, High Pressure Nitrogen Supply, and Process Radiation Monitoring Systems are described in some detail in the text of DCD Tier 2, Revision 1, Section 6.2.4.3.2, the DCD tables which are meant to describe in more detail the isolation provisions for these systems are blank and say "COL applicant to provide" (Tables 6.2-39 through 6.2-42). Is it intended that the COL applicants will be restrained by the DCD text in their detailed design of the systems as described in the tables that they will provide? If not, is it intended that the COL applicants will design the systems' isolation provisions as they see fit, to be reviewed by the staff at the COL stage?

GE Response

Revision 3 to DCD Tier 2 will reflect changes to the Containment Isolation Valve Tables 6.2-39 through 6.2-42 for the Chilled Water System and High Pressure Nitrogen Supply System to be consistent with the text for these systems in Subsection 6.2.4.3.2 as shown on the attached markup.

NRC RAI 6.2-129

DCD Tier 2, Revision 1, Section 6.2.4.3.2.4, "Evaluation Against General Design Criterion 57," states: "The ESBWR has no closed system lines penetrating the containment that require automatic isolation." Considering that, generally, closed systems inside containment do not require automatic isolation (e.g., remote-manual isolation is allowed), this is not very informative.

Are there any closed systems inside containment whose lines penetrate the containment? If so, describe their containment isolation provisions in the DCD. If not, clarify the DCD statement.

GE Response

DCD Tier 2, Subsection 6.2.4.3.2.4 is being revised by adding a closed system outside the containment. Please refer to the response to RAI 6.2-111.

No DCD Tier 2 changes will be made in response to this RAI.

6.2.4 Containment Isolation Function

The primary objective of the containment isolation function is to provide protection against releases of radioactive materials to the environment as a result of an accident. The objective is accomplished by isolation of lines or ducts that penetrate the containment vessel. Actuation of the containment isolation function is automatically initiated at specific limits defined for reactor plant operation. After the isolation function is initiated, it goes through to completion.

Relevant to the containment isolation function, this subsection addresses or references to other DCD locations that address the applicable requirements of General Design Criteria (GDC) 1, 2, 4, 16, 54, 55, 56, and 57 and Appendix K to 10 CFR Part 50 discussed in SRP 6.2.4 R2. Regulatory Guide 1.141 and ANS 56.2 are used as guidance documents for the design of containment isolation provisions for fluid systems. The plant meets the relevant requirements of

- GDC 1, 2, and 4 as they relate to safety-related systems 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.
- GDC 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 radioactive material to the environment.
- GDC 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 function incorporated to permit periodic operability testing of the containment isolation function, and leak rate testing of isolation valves.
- GDC 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:
  - One locked closed isolation valve inside and one locked closed isolation valve outside containment; or
  - One automatic isolation valve inside and one locked closed isolation valve outside containment; or
  - One locked closed isolation valve inside and one automatic isolation valve outside containment. **A simple check valve may not be used as the automatic isolation valve outside containment;** or

  - One automatic isolation valve inside and one automatic isolation valve outside containment. **A simple check valve may not be used as the automatic isolation valve outside containment.**

- GDC 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 outside containment. **This valve is to be outside containment and located as close to the containment as practical. A simple check valve may not be used as the automatic isolation valve.**

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

6.2.4.1 Design Bases

Safety Design Bases

- Containment isolation valves provide the necessary isolation of the containment in the event of accidents or other conditions and prevent the unfiltered release of containment contents that cannot be permitted by 10 CFR 50.34(a)(1) limits. Leak-tightness of the valves shall be verified by Type C test.

- Capability for rapid closure or isolation of all pipes or ducts that penetrate the containment is performed **by** means or devices **that provide a containment barrier** to limit leakage within permissible limits.

- The design of isolation valves for lines penetrating the containment follows the requirements of General Design Criteria 54 through 57 to the greatest extent practicable consistent with safety and reliability. **Exemptions from GDCs are listed in Table 1.9-6.**

- Isolation valves for instrument lines that penetrate the DW/containment conform to the requirements of Regulatory Guide 1.11.

- Isolation valves, actuators and controls are protected against loss of their safety-related function from missiles and postulated effects of high and moderate energy line ruptures.

- Design of the containment isolation valves and associated piping and penetrations meets the requirements for Seismic Category I components.

- Containment isolation valves and associated piping and penetrations meet the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Class 1, 2, or MC, in accordance with their quality group classification.

- The design of the control functions for automatic containment isolation valves ensures that resetting the isolation signal shall not result in the automatic reopening of containment isolation valves.

Design Requirements

The containment isolation function, automatically closes fluid penetrations of fluid systems not required for emergency operation. Fluid penetrations supporting ESF systems have remote manual isolation valves that can be closed from the control room, if required.

The isolation criteria for the determination of the quantity and respective locations of isolation valves for a particular system conform to General Design Criteria 54, 55, 56, 57, and Regulatory Guide 1.11. Redundancy and physical separation are required in the electrical and mechanical design to ensure that no single failure in the containment isolation function prevents the system from performing its intended functions.

Protection of Containment Isolation Function components from missiles is considered in the design, as well as the integrity of the components to withstand seismic occurrences without loss of operability. For power-operated valves used in series, no single event can interrupt motive power to both closure devices. Pneumatic-operated containment isolation valves are designed to fail to the closed position for containment isolation upon loss of the operator gas supply or electrical power.

The containment isolation function is designed to Seismic Category I. Safety and quality group classifications of equipment and systems are found in Table 3.2-1. Containment isolation valve functions are identified in Tables 6.2-16 through 6.2-42.

The criteria for the design of the Leak Detection and Isolation System (LD&IS), which provides containment and reactor vessel isolation control, are listed in Subsection 7.1.2. The bases for assigning certain signals for containment isolation are listed and explained in Subsection 7.3.3.

6.2.4.2 System Design

The containment isolation function is accomplished by valves and control signals, required for the isolation of lines penetrating the containment. The reactor coolant pressure boundary (RCPB) influent lines are identified in Table 6.2-13, and the RCPB effluent lines are identified in Table 6.2-14. Table 6.2-15 through 6.2-42 show the pertinent data for the containment isolation valves. A detailed discussion of the LD&IS controls associated with the containment isolation function is included in Subsection 7.3.3.

Power-operated containment isolation valves have position switches in the control room to show whether the valve is open or closed. Loss of power to each motor-operated valve is detected and annunciated. Power for valves used in series originates from physically independent sources without cross ties to assure that no single event can interrupt motive power to both closure devices.

All motor-operated isolation valves (including pneumatic-motor-operated valves) remain in their last position upon failure of valve power. All pneumatic-operated valves (not applicable to air-testable check valves) close on loss of gas supply.

The design of the containment isolation function includes consideration for possible adverse effects of sudden isolation valve closure when the plant systems are functioning under normal operation.

General compliance or alternate approach assessment for Regulatory Guide 1.26 may be found in Subsection 3.2.2. General compliance or alternate approach assessment for Regulatory Guide 1.29 may be found in Subsection 3.2.1.

Containment isolation valves are generally automatically actuated by the various signals in primary actuation mode or are remote-manually operated in secondary actuation mode. Other appropriate actuation modes, such as self-actuated check valves, are identified in the containment isolation valve information Tables 6.2-13 through 6.2-42.

6.2.4.2.1 Containment Isolation Valve Closure Times

Containment isolation valve closure times are established by determining the isolation requirements necessary to keep radiological effects from exceeding guidelines in 10 CFR 100. For system lines, which can provide an open path from the containment to the environment, a discussion of valve closure time bases is provided in Chapter 15. **However the design values of closure times for power-operated valves is more conservative than the above requirement. For valves above 80 mm (3 inches) upto and including 300 mm (12 inches) in diameter, the closure time is at least within a time determined by dividing the nominal valve diameter by 300 mm (12 inches) per minute. Valves 80 mm (3 inches) and less generally close within 15 seconds. All valves larger than 300 mm (12 inches) in diameter close within 60 seconds unless an accident radiation dose calculation is performed to show that the longer closure time does not result in a significant increase in off-site dose.**

6.2.4.2.2 Instrument Lines Penetrating Containment

Sensing instrument lines penetrating the containment follow all the recommendations of Regulatory Guide 1.11. Each line has a 6-mm (1/4-inch) orifice inside the DW, as close to the beginning of the instrument line as possible, a manually-operated isolation valve just outside the containment **followed by an excess flow check valve. The instrument line is designed such that the instrument response time is acceptable with the presence of the orifice, and that the flow restriction is not plugged.**

6.2.4.2.3 Compliance with General Design Criteria and Regulatory Guides

In general, all requirements of General Design Criteria 54, 55, 56, **57** and Regulatory Guides 1.11 **and 1.141** are met in the design of the containment isolation function. A case-by-case analysis of all such penetrations is given in Subsection 6.2.4.3.

6.2.4.2.4 Operability Assurance, Codes and Standards, and Valve Qualification and Testing

Protection is provided for isolation valves, actuators and controls against damage from missiles. All potential sources of missiles are evaluated. Where possible hazards exist, protection is afforded by separation, missile shields or by location outside the containment. Tornado missile protection is afforded by the fact that all containment isolation valves are inside the missile-proof reactor building. Internally-generated missiles are discussed in Subsection 3.5.1, and the conclusion is reached that there are no potentially damaging missiles generated. Dynamic effects from pipe break (jet impingement and pipe whip) are discussed in Section 3.6. The arrangement of containment isolation valves inside and outside the containment affords sufficient physical separation such that a high energy pipe break would not preclude containment isolation. The containment isolation function piping and valves are designed in accordance with Seismic Category I requirements.

Section 3.11 presents a discussion of the environmental conditions, both normal and accidental, for which the containment isolation valves and pipe are designed. **Containment isolation valves and associated pipes are designed to withstand the peak calculated temperatures and pressures during postulated design basis accidents to which they would be exposed.** The section discusses the qualification tests required to ensure the performance of the isolation valves under particular environmental conditions.

Containment isolation valves are designed in accordance with the requirements of ASME Code, Section III **and meet at least Group B quality standards, as defined in RG 1.26.** Where necessary, a dynamic system analysis **that** covers the impact effect of rapid valve closures under operating conditions is included in the design specifications of piping systems involving containment isolation valves. Valve operability assurance testing is discussed in Subsection 3.9.3.2. The power-operated and automatic isolation valves will be cycled during normal operation to assure their operability.

Subsection 6.2.6 describes leakage rate testing of containment isolation barriers.

6.2.4.2.5 Redundancy and Modes of Valve Actuations

The main objective of the Containment Isolation Function is to provide environmental protection by preventing releases of radioactive materials. This is accomplished by complete isolation of system lines penetrating the containment. Redundancy is provided in all design aspects to satisfy the requirement that no **single active failure of any kind should prevent** containment isolation.

Mechanical components are redundant, in that isolation valve arrangements provide backup in the event of accident conditions. Isolation valve arrangements satisfy all requirements specified in General Design Criteria 54, 55, 56 and 57, and Regulatory Guides 1.11 **and 1.141**.

Isolation valve arrangements with appropriate instrumentation are shown in the P&IDs. The isolation valves generally have redundancy in the mode of actuation, with the primary mode being automatic and the secondary mode being remote manual.

A program of testing (Subsection 6.2.4.4) is maintained to ensure valve operability and leak-tightness. The design specifications require each isolation valve to be operable under the most severe operating conditions that it may experience. Each isolation valve is afforded protection by separation and/or adequate barriers from the consequences of potential missiles.

Electrical redundancy is provided for each set of isolation valves, eliminating dependency on one power source to attain isolation. Electrical cables for isolation valves in the same line are routed separately. Cables are selected and based on the specific environment to which they may be subjected (e.g., magnetic fields, high radiation, high temperature and high humidity).

Administrative controls **will be applied by the plant operators by using established procedures and checklists for all non-powered containment isolation valves to** ensure that thei**r** position is maintained and known. The position of all power-operated isolation valves is indicated in the control room. Discussion of instrumentation and controls for the isolation valves is included in Subsection 7.3.3.

6.2.4.3 Design Evaluation

A discussion of the main objectives of the containment, the arrangements, the redundancies and the position control of all non-powered isolation valves and all power operated isolation valves is included in Subsection 6.2.4.2.5.

6.2.4.3.1 Evaluation Against General Design Criterion 55

The reactor coolant pressure boundary (RCPB), as defined in 10 CFR 50, Section 50.2, consists of the reactor pressure vessel, pressure-retaining appurtenances attached to the vessel, valves and pipes which extend from the reactor pressure vessel up to and including the outermost isolation valves. The lines of the RCPB, which penetrate the containment, include functions for isolation of the containment, thereby precluding any significant release of radioactivity. Similarly, for lines which do not penetrate the containment but which form a portion of the RCPB, the design ensures that isolation of the RCPB can be achieved.

The following paragraphs summarize the basis for ESBWR compliance with the requirements imposed by General Design Criterion 55.

6.2.4.3.1.1 Influent Lines

GDC 55 states that each influent line, which penetrate the containment directly to the RCPB, be equipped with at least two isolation valves, one inside the containment and the other as close to the external side of the containment as practical. Table 6.2-13 lists the influent pipes that comprise the RCPB and penetrate the containment. The table summarizes the design of each line as it satisfies the requirements imposed by General Design Criterion 55.

Feedwater Line

The feedwater line is part of the reactor coolant pressure boundary as it penetrates the containment to connect with the reactor pressure vessel. It has two automatically closing isolation valves. The isolation valve inside the containment is a check valve, located as close as practicable to the containment wall. Outside the containment is a spring-check valve located as close as practicable to the containment wall. The spring-check valve outside containment is provided with an air-opening, spring-closing operator, which, upon remote manual signal from the main control room, provides additional seating force on the valve disk to assist in long-term leakage protection. Should a break occur in the feedwater line, the check valves prevent significant loss of reactor coolant inventory and offer immediate isolation.

Isolation Condenser Condensate and Venting Lines

The isolation condenser condensate lines penetrate the containment and connect directly to the reactor pressure vessel. The isolation condenser venting lines extend from the isolation condenser through the containment and connect together downstream of two normally closed control valves in series. The venting line terminates below the minimum drawdown level in the suppression pool. An isolation condenser purge line also penetrates the containment and it contains an excess flow check valve and a normally open shutoff valve. Each IC condensate line has two open isolation gate-valves (F003 and F004) located in the containment where they are protected from outside environmental conditions, which may be caused by a failure outside the containment. In case of the venting lines there are two normally closed control globe-valves in series in each branch of the vent line. The condensate lines are automatically isolated when leakage is detected.

The IC condensate line isolation valves and the pipes penetrating the containment are designed in accordance to ASME Code Section III, Class 1 Quality Group A, Seismic Category I. Penetration sleeves used at the locations where the condensate return pipes exit the pool at the containment pressure boundary are designed and constructed in accordance with the requirements specified within Subsection 3.6.2.1. In addition, the IC System outside the containment consists of a closed loop designed to ASME Code Section III, Class 2, Quality Group B, Seismic Category I, which is a "passive" substitute for an open "active" valve outside the containment. This closed-loop substitute for an open isolation valve outside the containment implicitly provides greater safety. The combination of an already isolated loop outside the containment plus the two series automatic isolation valves inside the containment comply with the intent of isolation functions of US NRC Code of Federal Regulations 10 CFR 50, Appendix A, Criteria 55 and 56.

Standby Liquid Control System Line

The Standby Liquid Control (SLC) system line penetrates the containment to inject directly into the reactor pressure vessel. In addition to a simple check valve inside the containment, a check valve, together with two parallel squib-valves are located outside the DW. Because the SLC line is normally closed, rupture of this non-flowing line is extremely improbable. However, should a break occur subsequent to the opening of the squib-valves, the check valves ensure isolation.

All mechanical components required for boron injection are at least Quality Group B. Those portions which are part of the reactor coolant pressure boundary are classified Quality Group A.

6.2.4.3.1.2 Effluent Lines

GDC 55 states that each effluent line, which form part of the reactor coolant pressure boundary and penetrate the containment, be equipped with two isolation valves; one inside the containment and one outside, located as close to the containment wall as practicable.

Table 6.2-14 lists those effluent lines that comprise the reactor coolant pressure boundary and which penetrate the containment.

Main Steam and Drain Lines

The main steam lines, which extend from the reactor pressure vessel to the main turbine and condenser system, penetrate the containment. The main steam drain lines connect the low points of the steam lines, penetrate the containment and are routed to the condenser hotwell. For these lines, isolation is provided by automatically actuated globe-valves, one inside and one just outside the containment.

The main steamline isolation valves (MSIVs) are spring loaded, pneumatically-operated globe valves designed to close on loss of gas pressure or loss of power to the solenoid-operated pilot valves. Each valve has two pilot valves supplied from independent power sources, both of which must be de-energized to close the MSIV. Two MSIVs are used in series to assure isolation when needed. Each MSIV uses gas pressure for closure upon interruption of electrical power to the pilot valves. A spring closes the valve when there is no gas pressure. The separate and independent action of either gas pressure or spring force is capable of closing an isolation valve. Refer to Subsection 5.4.5 for Main Steamline Isolation System description.

Isolation Condenser Steam Supply Lines

The isolation condenser steam supply lines penetrate the containment and connect directly to the reactor pressure vessel. Two isolation gate-valves are located in the containment where they are protected from outside environmental conditions, which may be caused by a failure outside the containment. The isolation valves in each IC loop are signaled to close automatically on excessive flow. Flow is sensed by four differential flow transmitters in either the steam supply line, or the condensate drain line. The isolation valves are also automatically closed on high radiation in the steam leaving an IC-pool compartment. The isolation functions are based on any 2-out-of-4 channel trips.

The IC isolation valves and the pipe penetrating the containment are designed in accordance to ASME Code Section III, Class 1 Quality Group A, Seismic Category I. Penetration sleeves used at the locations where the IC steam supply lines enter the pool at the containment pressure boundary are designed and constructed in accordance with the requirements specified within Subsection 3.6.2.1. In addition to the IC isolation valves, the IC system outside the containment consists of a closed loop designed to ASME Code Section III, Class 2, Quality Group B, Seismic Category I, which is a "passive" substitute for an open "active" valve outside the containment. This closed-loop substitute for an open isolation valve outside the containment implicitly provides greater safety. The combination of an already isolated loop outside the containment plus the series automatic isolation valves inside the containment comply with the intent of isolation functions of US NRC Code of Federal Regulations 10 CFR 50, Appendix A, Criteria 55 and 56.

Reactor Water Cleanup System /Shutdown Cooling System

The Reactor Water Cleanup/Shutdown Cooling (RWCU/SDC) System consists of two independent trains. Each train takes its suction from the reactor pressure vessel mid-vessel region as well as from the reactor bottom. The suction lines of each train are isolated by one automatic nitrogen-operated gate valve inside and one air-operated gate valve outside the containment. The reactor bottom suction line has a sampling line isolated by one automatic nitrogen-operated globe valve inside and one air-operated globe valve outside the containment. RWCU/SDC pumps, heat exchangers and demineralizers are located outside the containment.

6.2.4.3.1.3 Conclusion on Criterion 55

In order to ensure protection against the consequences of accidents involving the release of radioactive material, pipes **that** form the reactor coolant pressure boundary are shown to provide adequate isolation capabilities on a case-by-case basis. In all cases, two isolation barriers were shown to protect against the release of radioactive materials.

In addition to meeting the isolation requirements stated in Criterion 55, the pressure-retaining components **that** comprise the reactor coolant pressure boundary are designed to meet other appropriate requirements **that** minimize the probability or consequences of an accidental pipe rupture. The quality requirements for these components ensure that they are designed, fabricated, and tested to the highest quality standards of all reactor plant components. The classification of **components, which comprise the reactor coolant pressure boundary,** are designed in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Class 1.

It is therefore concluded that the design of piping systems which comprise the reactor coolant pressure boundary and which penetrate the containment satisfies Criterion 55.

6.2.4.3.2 Evaluation Against Criterion 56

Criterion 56 requires that lines, which penetrate the containment and communicate with the containment atmosphere, must have two isolation valves; one inside the containment, and one outside, unless it can be demonstrated that the containment isolation functions for a specific class of lines are acceptable on some other basis.

The following paragraphs summarize the basis for ESBWR compliance with the requirements imposed by Criterion 56.

6.2.4.3.2.1 Influent Lines to Containment

Tables 6.2-33 through 6.2-42 identifies the isolation valve functions in the influent lines to the containment.

Fuel and Auxiliary Pool Cooling System

The lines from the Fuel and Auxiliary Pool Cooling System penetrate the containment separately and are connected to the drywell spray, the suppression pool and to the Gravity-Driven Cooling System (GDCS) pools. In each of these lines there are one **air-**operated isolation -valve outside and one check valve inside the containment. Only the

GDCS pool return line motor-operated isolation valve is automatically closed on a containment isolation signal.

Subsection 9.1.3.3 contains additional information about the containment isolation design for FAPCS including any justifications for deviation from the GDC 56 requirements.

Chilled Water System

Isolation is provided for the Chilled Water System (CWS) cooling lines penetrating containment. It is assumed that the nonsafety-related Seismic Category II coolant boundary of the CWS or Drywell Cooling System heat exchanger may fail, opening to the containment atmosphere. Therefore, Criterion 56 is applied to the design of the CWS containment penetration. The CWS containment influent lines have **an air** -operated gate valve outside and a **nitrogen**-operated gate inside the containment.

Containment Inerting System

The penetration of the Containment Inerting System consists of two in-series butterfly isolation valves (normally closed) in parallel with two in-series globe isolation valves. All isolation valves on these lines are outside of the containment to provide accessibility to the valves. **Both containment isolation valves are** located as close as practical to the containment. **The valve nearest to the containment is provided with a capability of detection and termination of a leak. The piping between the containment and the first isolation valve and the piping between the two isolation valves are designed as per requirements of SRP 3.6.2. These piping are also designed to**

- **meet Safety Class 2 design requirements**
- **withstand the containment design temperature**
- **withstand internal pressure from containment structural integrity test**
- **withstand loss-of-coolant accident transient and environment**
- **meet Seismic Category I design requirements**
- **are protected against a high energy line break outside of containment when needed for containment isolation.**

High Pressure Nitrogen Supply System

The High Pressure Nitrogen Supply System penetrates the containment **at two places. Each line has** one **air-operated** globe valve outside and one check valve inside **the** containment.

Passive Containment Cooling System

The passive containment cooling system (PCCS) does not have isolation valves as the heat exchanger modules and piping are designed as extensions of the safety-related containment. The design pressure of the PCCS is greater than twice the containment design pressure and the design temperature is same as the drywell design temperature.

6.2.4.3.2.2 Effluent Lines from Containment

Tables 6.2-33 through 6.2-42 identify the isolation functions in the effluent lines from the containment.

Fuel and Auxiliary Pools Cooling System Suction Lines

The FAPCS suction line from the GDCS pool is provided with two power-assisted isolation valves, one **nitrogen**-operated inside and one **air**-operated outside the containment.

The FAPCS suction line from the suppression pool has one isolation valve outside the containment as the first barrier and the FAPCS piping outside containment as the second barrier. Because the penetration can be under water under certain accident conditions, there can be no isolation valve located inside the containment. The valve is located as close as possible to the containment.

Subsection 9.1.3.3 contains additional information about the containment isolation design for FAPCS including any justifications for deviation from the GDC 56 requirements.

Chilled Water System

The CWS effluent lines penetrating the containment each **has an air**-operated gate valve outside containment and a **nitrogen**-operated gate valve inside the containment.

Containment Inerting System

The penetration of the Containment Inerting System consists of two in-series butterfly isolation valves (normally closed) in parallel with two in-series globe isolation valves. All isolation valves on these lines are outside of the containment to provide accessibility to the valves. **Both containment isolation valves are** located as close as practical to the containment. **The valve nearest to the containment is provided with a capability of detection and termination of a leak. The piping between the containment and the first isolation valve and the piping between the two isolation valves are designed as per requirements of SRP 3.6.2. These piping are also designed to**

- **meet Safety Class 2 design requirements**
- **withstand the containment design temperature**
- **withstand internal pressure from containment structural integrity test**
- **withstand loss-of-coolant accident transient and environment**
- **meet Seismic Category I design requirements**
- **are protected against a high energy line break outside of containment when needed for containment isolation.**

Process Radiation Monitoring System

The penetrations for the fission products monitor sampling lines consist of one sampling line and one return line. Each line uses three globe valves in series. One valve is a mechanical globe valve used for maintenance and is located close to the containment. The other two valves are air-operated solenoid valves and are used for isolation. All three valves are located outside the containment for easy access. The piping to these valves is considered an extension of the containment boundary.

Passive Containment Cooling System

The passive containment cooling system (PCCS) does not have isolation valves as the heat exchanger modules and piping are designed as extensions of the safety-related containment. The design pressure of the PCCS is greater than twice the containment design pressure and the design temperature is same as the drywell design temperature.

6.2.4.3.2.3 Conclusion on Criterion 56

In order to ensure protection against the consequences of an accident involving release of significant amounts of radioactive materials, pipes that penetrate the containment have been demonstrated to provide isolation capabilities on a case-by-case basis in accordance with Criterion 56.

In addition to meeting isolation requirements, the pressure-retaining components of these systems are designed to the quality standards commensurate with their importance to safety.

6.2.4.3.2.4 Evaluation Against General Design Criterion 57

Criterion 57 which is applicable to a closed system, requires that each line which penetrate the containment and is neither a part of reactor coolant pressure boundary nor connected directly to the containment atmosphere must have at least one containment isolation valve which should be either automatic, or lock closed, or capable of remote manual operation. The following paragraphs summarize the basis for ESBWR compliance with the requirements imposed by Criterion 57.

6.2.4.3.2.4.1 Effluent Lines from Containment

Table 6.2-33 identifies the isolation functions in the effluent lines from the containment.

Fuel and Auxiliary Pools Cooling System Suction Lines

The FAPCS suction line from the suppression pool has one isolation valve outside the containment as the first barrier and the FAPCS piping outside containment, which acts as a closed system is the second barrier. Because the penetration can be under water under certain accident conditions, there can be no isolation valve located inside the containment. The valve is located as close as possible to the containment.

Subsection 9.1.3.3 contains additional information about the containment isolation design for FAPCS including any justifications for deviation from the GDC 57 requirements.

6.2.4.3.2.5 Evaluation Against Regulatory Guide 1.11

Instrument lines that connect to the RCPB and penetrate the containment have 1/4-inch orifices and manual isolation valves, in compliance with Regulatory Guide 1.11 requirements.

6.2.4.3.3 Evaluation of Single Failure

A single failure can be defined as a failure of a component (e.g., a pump, valve, or a utility such as offsite power) to perform its intended safety-related functions as a part of a safety-related system. The purpose of the evaluation is to demonstrate that the safety-related function of the system would be completed even with that single failure. Appendix A to 10 CFR 50 requires that electrical systems be designed specifically against a single passive or active failure. Section 3.1 describes the implementation of these standards, as well as General Design Criteria 17, 21, 35, 38, 41, 44, 54, 55 and 56.

Electrical and mechanical systems are designed to meet the single-failure criterion, regardless of whether the component is required to perform a safety-related action or function. Even though a component, such as an electrically-operated valve, is not designed to receive a signal to change state (open or closed) in a safety scheme, it is assumed as a single failure if the system component changes state or fails. Electrically-operated valves include valves that are electrically piloted but air/nitrogen-operated, as well as valves that are directly operated by an electrical device. In addition, all electrically-operated valves that are automatically actuated can also be manually actuated from the main control room. Therefore, a single failure in any electrical system is analyzed, regardless of whether the loss of a safety-related function is caused by a component failing to perform a requisite mechanical motion or a component performing an unnecessary mechanical motion. **Each of the power operated containment isolation valves for any given penetration is powered from a different division in order to meet the single failure criteria.**

6.2.4.4 Test and Inspections

The containment isolation function is scheduled to undergo periodic testing during reactor operation. The functional capabilities of power-operated isolation valves are tested remote-manually from the control room. By observing position indicators and changes in the affected system operation, the closing ability of a particular isolation valve is demonstrated.

A discussion of leak rate testing of isolation valves is provided in Subsection 6.2.6.

6.2.8.4 Deleted

Table 6.2-23

Containment Isolation Valve Information for the Isolation Condenser System Loop A

Closure Time (sec)	< 60	< 60	< 35	< 35

* With respect to meeting the intent of US NRC 10CFR 50, Appendix A, General Design Criteria 55, the closed loop safety-related IC loop outside the containment is a "passive" substitute for an open "active" valve outside the containment. This closed loop substitute for an open isolation valve outside the containment implicitly provides greater safety. The combination of an already isolated loop outside the containment plus the two series automatic isolation valves inside the containment comply with the intent of the isolation guidelines of 10 CFR50, App.A, Criterion 55 and 56.

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-25

Containment Isolation Valve Information for the Isolation Condenser System Loop B

Closure Time (sec)	< 60	< 60	< 35	< 35

* With respect to meeting the intent of US NRC 10CFR 50, Appendix A, General Design Criteria 55, the closed loop safety-related IC loop outside the containment is a "passive" substitute for an open "active" valve outside the containment. This closed loop substitute for an open isolation valve outside the containment implicitly provides greater safety. The combination of an already isolated loop outside the containment plus the two series automatic isolation valves inside the containment comply with the intent of the isolation guidelines of 10 CFR50, App.A, Criterion 55 and 56.

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-27

Containment Isolation Valve Information for the Isolation Condenser System Loop C

Closure Time (sec)	< 60	< 60	< 35	< 35

* With respect to meeting the intent of US NRC 10CFR 50, Appendix A, General Design Criteria 55, the closed loop safety-related IC loop outside the containment is a "passive" substitute for an open "active" valve outside the containment. This closed loop substitute for an open isolation valve outside the containment implicitly provides greater safety. The combination of an already isolated loop outside the containment plus the two series automatic isolation valves inside the containment comply with the intent of the isolation guidelines of 10 CFR50, App.A, Criterion 55 and 56.

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-29

Containment Isolation Valve Information for the Isolation Condenser System Loop D

Closure Time (sec)	< 60	< 60	< 35	< 35

* With respect to meeting the intent of US NRC 10CFR 50, Appendix A, General Design Criteria 55, the closed loop safety-related IC loop outside the containment is a "passive" substitute for an open "active" valve outside the containment. This closed loop substitute for an open isolation valve outside the containment implicitly provides greater safety. The combination of an already isolated loop outside the containment plus the two series automatic isolation valves inside the containment comply with the intent of the isolation guidelines of 10 CFR50, App.A, Criterion 55 and 56.

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-24

Containment Isolation Valve Information for the Isolation Condenser System Loop A

Closure Time (sec)	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30

* The piping and valve arrangement for these lines meet the intent of 10CFR50, App. A, GDC 55 because there are two normally closed valves in series in the line that leads from the suppression chamber back to the closed IC loop outside the containment.

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-26

Containment Isolation Valve Information for the Isolation Condenser System Loop B

Closure Time (sec)	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30

* The piping and valve arrangement for these lines meet the intent of 10CFR50, App. A, GDC 55 because there are two normally closed valves in series in the line that leads from the suppression chamber back to the closed IC loop outside the containment.

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-28

Containment Isolation Valve Information for the Isolation Condenser System Loop C

Closure Time (sec)	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30

* The piping and valve arrangement for these lines meet the intent of 10CFR50, App. A, GDC 55 because there are two normally closed valves in series in the line that leads from the suppression chamber back to the closed IC loop outside the containment.

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-30

Containment Isolation Valve Information for the Isolation Condenser System Loop D

Closure Time (sec)	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30

* The piping and valve arrangement for these lines meet the intent of 10CFR50, App. A, GDC 55 because there are two normally closed valves in series in the line that leads from the suppression chamber back to the closed IC loop outside the containment.

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-31

Containment Isolation Valve Information for the Reactor Water Cleanup/Shutdown Cooling System

Closure Time (sec)	< 30	< 30	< 15	< 15	< 30	< 30	< 15	< 15

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-31a

Containment Isolation Valve Information for the Reactor Water Cleanup/Shutdown Cooling System

Closure Time (sec)	< 15	< 15	< 15	< 15

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-33

Containment Isolation Valve Information for the Fuel and Auxiliary Pools Cooling System

Applicable Basis	GDC 57	GDC 56	GDC 56
Closure Time (sec)	< 30	< 30	N/A

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-34

Containment Isolation Valve Information for the Fuel and Auxiliary Pools Cooling System

Closure Time (sec)	< 30	< 30	< 30	N/A

Note: For explanation of codes, see legend on Table 6.2-15.

Table 6.2-35

Containment Isolation Valve Information for the Fuel and Auxiliary Pools Cooling System

Closure Time(sec)	< 30	N/A

Note: For explanation of codes, see legend on Table 6.2-15.