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MFN 06-466 Supplement 3

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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 79 Related to ESBWR Design Certification Application - Containment Systems - RAI Number 6.2-122 S01**

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) response to the subject NRC RAI originally transmitted via the Reference 1 letter and supplemented by an NRC request for clarification in Reference 2.

If you have any questions or require additional information, please contact me.

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 06-393, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 79 Related to ESBWR Design Certification Application*, October 11, 2006
2. E-Mail from Shawn Williams, U.S. Nuclear Regulatory Commission, to George Wadkins, GE Hitachi Nuclear Energy, dated May 30, 2007 (ADAMS Accession Number ML071500023)

Enclosure:

1. MFN 06-466 Supplement 3 - Response to Portion of NRC Request for Additional Information Letter No. 79 - Related to ESBWR Design Certification Application - Containment Systems - RAI Number 6.2-122 S01

cc:	AE Cubbage	USNRC (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	GB Stramback	GEH/San Jose (with enclosures)
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	eDRF	0000-0073-5385R1

Enclosure 1

MFN 06-466 Supplement 3

Response to Portion of NRC Request for

Additional Information Letter No. 79

Related to ESBWR Design Certification Application

Containment Systems

RAI Number 6.2-122 S01

NRC RAI 6.2-122:

DCD Tier 2, Revision 1, Section 6.2.4.3.2.1, "Influent Lines to Containment," under the heading "Fuel and Auxiliary Pool Cooling System," states that subsection 9.1.3.3 contains additional information about the containment isolation design for the system including any justifications for deviation from the GDC 56 requirements.

Provide this information in Section 6.2.4.3.2.1.

GEH Response:

In order to minimize the risk of errors and inconsistencies in future DCD updates, it is preferable to provide a detailed description in only one location and reference it as needed in other sections. By taking this approach, fewer DCD changes will be required if this information needs to be revised in the future. Regulatory Guide 1.70 supports this approach.

DCD Impact:

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

NRC RAI 6.2-122 S01:

RAI 6.2-122 requested that information about the containment isolation design for the Fuel and Auxiliary Pools Cooling System, currently located in DCD, Tier 2, Revision 3, Subsection 9.1.3.3, be provided in Subsection 6.2.4.3.2.1. The applicant responded:

> *In order to minimize the risk of errors and inconsistencies in future DCD updates, it is preferable to provide a detailed description in only one location and reference it as needed in other sections. By taking this approach, fewer DCD changes will be required if this information needs to be revised in the future. Regulatory Guide 1.70 supports this approach.*

Supplemental Request:

The staff does not disagree that a single location for detailed information is preferable. However, the staff believes that the containment isolation design information in Subsection 9.1.3.3 does not belong there. It should be removed from Subsection 9.1.3.3 and placed in Subsection 6.2.4.3.2.1.

The staff reviewed DCD, Revision 3, Subsection 9.1.3.3, information and associated tables. Please address the following:

A. *Subsection 9.1.3.3 states that the containment isolation valves (CIVs) in the suppression pool supply and return lines fail as-is on loss of electric power or the air supply.*

   1. *DCD, Tier 2, Revision 3, Table 6.2-33a agrees with this for the "A" lines. To the contrary, Table 6.2-33b states that the CIVs fail closed in the "B" lines. Correct this discrepancy.*

2. *The DCD simply states that the CIVs in the suppression pool supply and return lines fail as-is on loss of electric power or the air supply, without any explanation or justification as to why this is acceptable. GDC 55 and 56 state that, upon loss of actuating power, automatic isolation valves shall be designed to take the position that provides greater safety. SRP 6.2.4, Revision 2, section II.6.j, and ANS-56.2/ANSI N271-1976, sections 4.4.3 and 4.4.7, provide guidance for this requirement. Normally, a CIV should take the post-accident position upon failure; the post-accident position for these valves is "closed," per the DCD tables. The two CIVs in each suction line are both nitrogen-motor operated without accumulator (NMO) valves, which, by their nature, fail as-is. The guidance documents allow both CIVs in a line to be motor-operated if independent power sources serve the two valves, so that a single power failure does not fail both valves.*

   Considering that the subject valves will fail on loss of either electric power or the air (or nitrogen) supply, provide in the DCD an explanation of the manner in which the CIVs in the suction line(s) are protected from a single power failure rendering both valves inoperable, and potentially open, during an accident.

B. *In the suppression pool suction lines, having both CIVs located outside containment is acceptable per section II.6.d of SRP 6.2.4, Revision 2, as cited in the DCD, except for the following two points:*

   1. *There is no indication as to whether the design provides a capability to detect leakage from the valve shaft and/or bonnet seals and terminate the leakage, which is also a provision of section II.6.d of SRP 6.2.4, Revision 2. Provide the missing information in the DCD.*

   2. *Note that the option of having both CIVs in a line outside of containment is available only for engineered safety feature (ESF) or ESF-related systems, or systems needed for safe shutdown of the plant. Tables 6.2-33a and 6.2-33b state that these lines are not ESF. Discuss in the DCD whether the suppression pool suction lines satisfy this SRP criterion (for example, are ESF-related or needed for safe shutdown), and, if not, justify the deviation from the guidelines.*

C. *DCD, Tier 2, Revision 3, Tables 6.2-33a through 6.2-35, provide containment isolation design information for seven containment penetrations in the Fuel and Auxiliary Pools Cooling System, designated G21-MPEN-0001 through G21-MPEN-0007. However, DCD, Tier 2, Revision 3, contains a new table, Table 6.2-47, "Containment Penetrations Subject to Type A, B, and C Testing." This table indicates that there is an additional penetration in the system, designated G21-MPEN-TBD (To Be Determined?) and described as the Reactor Well Drain Line. Provide in the DCD containment isolation design information for this penetration.*

GEH Response:

Information contained in DCD Subsection 9.1.3 related to containment isolation shall be deleted and added to Subsection 6.2.4.

A. The information in Subsection 9.1.3.3 for the containment isolation valves (CIVs) in the Fuel and Auxiliary Pools Cooling System (FAPCS) suppression pool supply and return lines will be addressed in DCD Tier 2 as follows:

1. DCD Tier 2, Table 6.2-33b, will be corrected to be consistent with DCD Tier 2, Table 6.2-33a for CIV position in case of power failure.

2. The CIVs on the FAPCS suppression pool suction and return lines are considered to fail in the position of greatest safety. The CIVs in the suppression pool supply and return lines are closed for all normal operating conditions except for temporary usage when the suppression pool cooling / cleaning is needed. However, if Suppression Pool Cooling mode has been initiated prior to an accident, then it is more desirable to continue removing decay heat than to terminate the mode and isolate the system. This will be clarified in DCD Tier 2, Subsection 6.2.4.3.2.

   Therefore, the fail as-is feature allows these valves to remain in an open position, which provides additional reliability for the Regulatory Treatment of Non-Safety Systems (RTNSS) functions of Suppression Pool Cooling and Low Pressure Coolant Injection. This additional reliability is credited to address uncertainty in the Probabilistic Risk Assessment (PRA) safety goals.

   Furthermore, the CIVs are designed to accommodate a single failure such that the line can still be isolated with the loss of a single division of power. DCD Tier 2, Tables 6.2-33a and 6.2-33b, will be modified such that the electrical divisions are assigned in such a way that supports single failure N-2 design philosophy.

B. Having both CIVs located outside containment for the FAPCS suppression pool suction lines is justified as follows:

1. A description of leak detection provisions will be added to DCD Tier 2, Subsection 6.2.4.3.2.2.

2. While the function of Suppression Pool Cooling and Low Pressure Coolant Injection are not considered Engineered Safety Features, they are considered RTNSS backups to Engineered Safety Features, including the Passive Containment Cooling System (PCCS) and Gravity-Driven Cooling System (GDCS). Therefore, the regulatory treatment that has been assigned to these functions that utilize the FAPCS suppression pool flow path is justification for using provisions of SRP 6.2.4, Revision 2, Subsection II.6.d. No DCD change is required.

C. DCD Tier 2, Table 6.2-35 will be revised to add a column for MPEN-0008 for the Reactor Well drain line. A similar change will be made to DCD Tier 2, Table 6.2-47, where MPEN-TBD will be replaced with MPEN-0008.

DCD Impact:

DCD Tier 2, Table 3.9-8, Subsection 6.2.4.3.2.1, Subsection 6.2.4.3.2.2, Subsection 6.2.4.3.2.3, Table 6.2-33a, Table 6.2-33b, Table 6.2-35, Table 6.2-47, Subsection 9.1.3.2, and Subsection 9.1.3.3 will be revised as shown in the attached markup.

Table 3.9-8

In-Service Testing

No.	Qty	Description (g)	Valve Type (i)	Act (b)	Code Class (a)	Code Cat. (c)	Valve Func. (d)	Norm Pos	Safety Pos.	Fail Safe Pos	CIV	Test Para (e)	Test Freq. (f)
G21 Fuel and Auxiliary Pools Cooling System (FAPCS) Valves													
F210	1	Emergency makeup spent fuel pool water line check valve (g3)	CK	SA	3	C	A	O	O/C	N/A	--	SO SC	RO RO
F211	1	Emergency makeup spent fuel pool water line shutoff valve (g3)	QBL, GT	M	3	B	A	C	O	N/A	--	SO	RO
F212	1	Reactor well drain line containment isolation valve	QBL, GT	M	2	A	P	C	C	N/A	Y	L P	App J 2 yrs
F213	1	Reactor well drain line containment isolation valve	QBL, GT	M	2	A	P	C	C	N/A	Y	L P	App J 2 yrs
F303	1	GDCS pool return line outboard isolation valve	GT	AO	2	A	A	C	C	C	Y	SC FC L P	3 mo 3 mo App J 2 yrs
F304	1	GDCS pool return line inboard isolation check valve (g1)	CK	SA	2	A, C	A	C	C	N/A	Y	SO SC L	RO RO App J

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 GDCS pools, and to the Reactor Well Drain.

The Reactor Well drain line contains two manual valves inside the containment that are locked closed during normal operation. This arrangement is an exception to GDC 56, which requires that such lines contain one isolation valve outside and one isolation valve inside the containment. The alternative arrangement with both valves inside containment is necessary because a valve outside containment would be submerged in the reactor well, making it inaccessible and less reliable. The isolation valves are located as close as possible to the containment and the piping between the outermost valve and the containment boundary shall be designed to conservative requirements to preclude breaks in this area.

In each of these remaining influent lines there is one pnuematic-operated or equivalent– shutoff valve outside and one check valve inside the containment. Only the GDCS pool return line pneumatic-operated or equivalent shutoff 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 non safety-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 a pneumatic-operated or equivalent shutoff valve outside and a pneumatic-operated or equivalent shutoff inside the containment.

Containment Inerting System

The penetration of the Containment Inerting System consists of two tandem quarter-turn or equivalent shutoff valves (normally closed) in parallel with two tandem stop or shutoff 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; and
- 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 shutoff valve outside and one check valve inside the containment.

Passive Containment Cooling System

The 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 shutoff valves, one pneumatic-operated or equivalent inside and one pneumatic-operated or equivalent outside the containment.

Before it exits containment, the FAPCS suction line from the suppression pool branches into two parallel lines, each of which penetrate the containment boundary. Once outside, each parallel flow path contains two pneumatic isolation valves in series after which the lines converge back into a single flow path. The CIVs are normally closed and fail as-is for improved reliability. "Fail as-is" valves are acceptable because the valves are normally closed, will only be open when it is necessary to provide cooling to the suppression pool, and do not communicate with the drywell atmosphere. This arrangement is an exception to GDC 56, which requires that such lines contain one isolation valve outside and one isolation valve inside the containment. Such an alternative arrangement is necessary ~~B~~because ~~the penetration~~an inboard valve ~~can~~ could potentially be under water under certain accident conditions~~, there can be no isolation valve located inside the containment~~. Leak detection is provided for CIVs on the suppression pool suction line and ~~T~~the valves are located as close as possible to the containment.

~~Subsection 9.1.3.3 contains additional information about the containment isolation design for FAPCS~~

Chilled Water System

The CWS effluent lines penetrating the containment each has a pneumatic-operated or equivalent shutoff valve outside containment and a pneumatic-operated or equivalent shutoff valve inside the containment.

Containment Inerting System

The penetration of the Containment Inerting System consists of two tandem quarter-turn shutoff valves (normally closed) in parallel with tandem stop or shutoff 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; and
- 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 tandem stop or shutoff valves. One valve is a manual-operated valve used for maintenance and is located close to the containment. The other two valves are pneumatic, solenoid or equivalent power operated 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 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. Exceptions were taken in the cases of the Reactor Well drain line, and suppression pool suction line in the Fuel and Auxiliary Pools Cooling System, and they have been shown to be an adequate alternative to the explicit requirements of GDC 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.

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

Table 6.2-33a

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

Penetration Identification	G21-MPEN-0005		G21-MPEN-0002	
Valve No.	F321A	F322A	F306A	F307A
Applicable Basis	GDC 56	GDC 56	GDC 56	GDC 56
Tier 2 Figure	9.1-1	9.1-1	9.1-1	9.1-1
ESF	No	No	No	No
Fluid	Water	Water	Water	Water
Line Size	250 mm.	250 mm.	250 mm.	250 mm.
Type C Leakage Test	Yes	Yes	Yes	Yes
Pipe Length from Cont. to Inboard/Outboard Isolation Valve	COL holder to provide	COL holder to provide	COL holder to provide	COL holder to provide
Leakage Through Packing(a)	(a_1)	(a_1)	(a_1)	N/A
Leakage Past Seat(b)	b6	b6	b6	b6
Location	Outboard	Outboard	Outboard	Inboard
Valve Type	GT, QT, AF	GT, QT, AF	GT, QT, AF	CK, AF
Operator(c)	NMO	NMO	NMO	N/A
Normal Position	Closed	Closed	Closed	N/A
Shutdown Position	Closed	Closed	Closed	N/A
Post-Acc Position	Closed	Closed	Closed	N/A
Power Fail Position	As-is	As-is	As-is	N/A
Cont. Iso. Signal(d)	P	P	P	Q
Primary Actuation	Remote manual	Remote manual	Remote manual	Flow
Secondary Actuation	Local manual	Local manual	Local manual	N/A
Closure Time (sec)	<30	<30	<30	N/A
Power Source	Div. 1, 3	Div. ~~1~~2, ~~3~~4	Div. 1, 3	N/A

Table 6.2-33b

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

Penetration Identification	G21-MPEN-0007		G21-MPEN-0006	
Valve No.	F321B	F322B	F306B	F307B
Applicable Basis	GDC 56	GDC 56	GDC 56	GDC 56
Tier 2 Figure	9.1-1	9.1-1	9.1-1	9.1-1
ESF	No	No	No	No
Fluid	Water	Water	Water	Water
Line Size	250 mm.	250 mm.	250 mm.	250 mm.
Type C Leakage Test	Yes	Yes	Yes	Yes
Pipe Length from Cont. to Inboard/Outboard Isolation Valve	COL holder to provide	COL holder to provide	COL holder to provide	COL holder to provide
Leakage Through Packing[a]	(a_1)	(a_1)	(a_1)	N/A
Leakage Past Seat[b]	b6	b6	b6	b6
Location	Outboard	Outboard	Outboard	Inboard
Valve Type	GT, QT, AF	GT, QT, AF	GT, QT, AF	CK, AF
Operator[c]	NMO	NMO	NMO	N/A
Normal Position	Closed	Closed	Closed	N/A
Shutdown Position	Closed	Closed	Closed	N/A
Post-Acc Position	Closed	Closed	Closed	N/A
Power Fail Position	As-is	As-is	As-is	N/A
Cont. Iso. Signal[d]	P	P	P	Q
Primary Actuation	Remote manual	Remote manual	Remote manual	Self
Secondary Actuation	Local manual	Local manual	Local manual	N/A
Closure Time (sec)	<30	<30	<30	N/A
Power Source	Div. 21, 43	Div. 2, 4	Div. 2, 4	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

Penetration Identification	G21-MPEN-0001		G21-MPEN-0008	
Valve No.	F309	F310	F212	F213
Applicable Basis	GDC 56	GDC 56	GDC 56	GDC 56
Tier 2 Figure	9.1-1	9.1-1	9.1-1	9.1-1
ESF	No	No	No	No
Fluid	Water	Water	Water	Water
Line Size	250 mm.	250 mm.	250 mm.	250 mm.
Type C Leakage Test	Yes	Yes	Yes	Yes
Pipe Length from Cont. to Inboard/Outboard Isolation Valve	COL holder to provide	COL holder to provide	COL holder to provide	COL holder to provide
Leakage Through Packing[a]	(a_1)	N/A	(a_1)	(a_1)
Leakage Past Seat[b]	b6	b6	b6	b6
Location	Outboard	Inboard	Inboard	Inboard
Valve Type	GB, AF	CK, AF	GT, QBL	GT, QBL
Operator[c]	AO	N/A	N/A	N/A
Normal Position	Closed	N/A	Closed	Closed
Shutdown Position	Closed	N/A	Open / Closed	Open / Closed
Post-Acc. Position	Closed[1]	N/A	Closed	Closed
Power Fail Position	Closed	N/A	N/A	N/A
Cont. Iso. Signal[d]	P	Q	R	R
Primary Actuation	Electrical	Flow	Manual	Manual
Secondary Actuation	Remote manual	N/A	N/A	N/A
Closure Time(sec)	<35	N/A	N/A	N/A
Power Source	Div. 1, 2, 3	N/A	N/A	N/A

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

Table 6.2-47

Containment Penetrations Subject To Type A, B, and C Testing

Penetration Number (1)	Description	Location (3)/Room #	RCCV Sector	Penetration Type (4)	Leak Test Type (5)
Piping Penetrations					
G21: Fuel and Auxiliary Pools Cooling System (FAPCS)					
G21-MPEN-0001	Drywell Spray Discharge Line	UD	TBD	C	A
G21-MPEN-0002	Suppression Pool Return Line A	UD	TBD	C	A
G21-MPEN-0003	GDCS Pool Return Line	UD	TBD	C	A
G21-MPEN-0004	Suction Line from GDCS Pool	UD	TBD	C	A
G21-MPEN-0005	Suction Line A from Suppression Pool	LD	TBD	C	A
G21-MPEN-0006	Suppression Pool Return Line B	UD	TBD	C	A
G21-MPEN-0007	Suction Line B from Suppression Pool	LD	TBD	C	A
G21-MPEN-~~TBD~~0008	Reactor Well Drain Line	TS	TBD	C	A

9.1.3 Fuel and Auxiliary Pools Cooling System

9.1.3.1 Design Bases

Safety Design Basis

Fuel and Auxiliary Pools Cooling System (FAPCS) is a nonsafety-related system, except for the following safety-related items:

- Containment isolation valves,
- High-pressure interface with the Reactor Water Cleanup / Shutdown Cooling System, and
- Emergency water supply flow paths.

Power Generation Design Basis

FAPCS provides continuous cooling and cleaning of the spent fuel storage pool during normal plant operation. It also provides occasional cooling and cleaning of various pools located inside the containment during normal plant operation and refueling outage.

9.1.3.2 System Description

System Description Summary

The FAPCS consists of two physically separated cooling and cleanup (C/C) trains, each with 100% capacity during normal operation. Each train contains a pump, a heat exchanger and a water treatment unit for cooling and cleanup of various cooling and storage pools except for the Isolation Condenser and Passive Containment Cooling (IC/PCC) pools (refer to Figure 9.1-1). A separate subsystem with its own pump, heat exchanger and water treatment unit is dedicated for cooling and cleaning of the IC/PCC pools independent of the FAPCS C/C train operation during normal plant operation (refer to Figure 9.1-1).

The primary design function of FAPCS is to cool and clean pools located in the containment, Reactor Building and Fuel Building (refer to Table 9.1-1) during normal pant operation. FAPCS provides flow paths for filling and makeup of these pools during normal plant operation and during post accident conditions, as necessary.

FAPCS is also designed to provide the following accident recovery functions in addition to the Spent Fuel Pool cooling function:

- Suppression pool cooling (SPC);
- Drywell spray;
- Low pressure coolant injection (LPCI) of suppression pool water into the RPV; and
- Alternate Shutdown Cooling.

In addition to its accident recovery function, suppression pool cooling (SPC) mode is also designed to automatically initiate during normal operation in response to a high temperature signal from the suppression pool.

Redundancy and physical separation are provided in accordance with SECY 03-087 for active components in lines dedicated to LPCI and SPC modes.

During normal plant operation, at least one FAPCS C/C train is available for continuous operation to cool and clean the water of the Spent Fuel Pool, while the other train can be placed in standby or other mode for cooling the Gravity Driven Cooling System (GDCS) pools and suppression pool. If necessary during refueling outage, both trains may be used to provide maximum cooling capacity for cooling the Spent Fuel Pool. The water treatment units can be bypassed when necessary, and will be bypassed automatically on a high temperature signal downstream of the heat exchangers.

Each FAPCS C/C train has sufficient flow and cooling capacity to maintain Spent Fuel Pool bulk water temperature below 48.9°C (120°F) under normal Spent Fuel Pool heat load conditions (normal heat load condition is defined as irradiated fuel in the Spent Fuel Pool resulting from 20 years of plant operations). During the maximum Spent Fuel Pool heat load conditions of a full core off-load plus irradiated fuel in the Spent Fuel Pool resulting from 20 years of plant operations, both FAPCS C/C trains are needed to maintain the bulk temperature below 60°C (140°F).

During a loss of the FAPCS cooling trains, the cooling to the Spent Fuel Pool and IC/PCC pools is accomplished by allowing the water to heat and boil. Sufficient pool capacity exists for pool boiling to continue for at least 72 hours post-accident, at which point post accident makeup water can be provided through safety-related connections to the Fire Protection System (FPS) or another onsite or offsite water source.

All operating modes (refer to Table 9.1-2) are manually initiated and controlled from the Main Control Room (MCR), except the SPC mode, which is initiated either manually, or automatically on high suppression pool water temperature signal. Instruments are provided for indication of operating conditions to aid the operator during the initiation and control of system operation. Provisions are provided to prevent inadvertent draining of the pools during FAPCS operation by including anti-siphon holes on all FAPCS piping that is normally submerged.

The FAPCS is designed to provide for the collection, monitoring, and drainage of pool liner leaks from the spent fuel pools, auxiliary pools, and IC/PCC pools (refer to Table 9.1-1) to the Liquid Waste Management System.

Containment isolation valves are provided on the lines that penetrate the primary containment and are powered from independent safety-related sources. ~~Pneumatic-operated valves with containment isolation function are designed to fail in the position of greatest safety upon loss of its electric power or air supply. All containment isolation valves fail to the closed position with the exception of isolation valves needed for the functions of SPC which fail as is.~~

With the exception of valves needed to perform accident recovery functions described above, the containment isolation valves are automatically closed upon receipt of a containment isolation signal from the Leakage Detection and Isolation System (LD&IS), with the exception of the containment isolation valves needed for post-accident recovery modes, which do not receive an isolation signal.

The FAPCS is a nonsafety-related system with the exception of piping and components required for:

- Containment isolation;

- Refilling of the IC/PCC pools and the Spent Fuel Pool with post-accident water supplies from the Fire Protection System or another onsite or offsite source.
- The high-pressure interface with the Reactor Water Cleanup/Shutdown Cooling system used for low pressure coolant injection.

The piping and components needed for the following functions are classified as RTNSS:

- Suppression pool cooling
- Low pressure coolant injection

The FAPCS piping and components that are required to support safety-related and/or accident recovery function have Quality Group B or C and Seismic I classification (Table 9.1-3). A Seismic I classification is required for all safety-related functions listed above. A Seismic II classification is sufficient for the remaining nonsafety-related piping and components that support accident recovery functions. This classification satisfies the requirements of SRP 9.1.3 Section I.1.

Detailed System Description

The FAPCS is provided with two cooling and cleanup (C/C) trains with 100% capacity during normal operation. Each FAPCS train is physically separated and has one pump, one heat exchanger and one water treatment unit consisting of a prefilter and a demineralizer.

A manifold of four motor operated valves is attached to each end of the FAPCS C/C trains [refer to Figure 9.1-1]. These manifolds are used to connect the FAPCS C/C train with one of the two pairs of suction and discharge piping loops to establish the desired flow path during FAPCS operation. One loop is used for the fuel pools and auxiliary pools, and the other loop for the GDCS pools and suppression pool and for injecting water to drywell spray sparger and reactor vessel via the RWCU/SDC System and feedwater pipes.

The use of manifolds with proper valve alignment and separate suction-discharge piping loops 1) allows operating of one train independent of the other train to permit on-line maintenance or dual mode operation using separate trains if necessary, 2) prevents inadvertent draining of the pool and minimizes mixing of contaminated water in the Spent Fuel Pool with cleaner water in other pools.

Each water treatment unit is equipped with a prefilter, a demineralizer and a post strainer. A bypass line is provided to permit bypass of the water treatment unit, when necessary. To protect demineralizer resin, the water treatment units are bypassed automatically on a high temperature signal. The prefilter and demineralizers of the water treatment units are located in shielding cells so that radiation exposure of plant personnel is within acceptable limits.

Proper physical separation is provided between the active components of the two redundant trains to assure operation of one train in the event of failure of the other train.

A reactor makeup water discharge line is provided for injecting suppression pool water or water from the Fire Protection System to the reactor vessel via Reactor Water Cleanup/Shutdown Cooling System (/SDC) Loop B and Feedwater Loop A discharge pipes. This injection line includes redundant shutoff valves such that the flow path branches to include two parallel flow paths, each with a motor-operated gate valve (refer to Figure 9.1-1). This line branches again downstream of the shutoff valves to include two pairs of safety-related isolation check valves (two regular check valves upstream and two testable check valves downstream). This line is safety-related between the upstream pair of isolation check valves and the RWCU/SDC interface. The safety-related check valves and downstream piping are designed to withstand the high pressure RWCU/SDC System. The motor-operated shutoff valves fail as-is, are normally closed, and are prevented from opening by a high reactor pressure signal from the Nuclear Boiler System to protect the low pressure portion of FAPCS piping and components. Redundant valves are contained in separate fire zones for improved reliability.

A drywell spray discharge line and a ring header with spray nozzles mounted on the header are provided for spraying water inside the drywell to reduce the drywell pressure 72 hours following a LOCA to assist in post accident recovery. In order to prevent excessive negative pressure the drywell spray flow rate must be less than 227 m^3/hr (1000 gpm). The drywell spray flow rate is maintained below this value by a flow-restricting orifice. The ring header equipped with spray nozzles is located in the drywell.

A separate cooling and cleanup subsystem completely independent of FAPCS C/C trains and their piping loop is provided for cooling and cleanup of the IC and PCC pools to prevent radioactive contamination of these pools. The subsystem consists of one pump, one heat exchanger, and one water treatment unit.

FAPCS contains two containment isolation valves on the lines that penetrate the primary containment. ~~One isolation valve is located inside the containment and the other isolation valve is outside the containment, except for the suppression pool suction line where both valves are located outside containment. For added reliability, the suppression pool suction and return lines branch to form parallel flow paths as they penetrate containment. The suppression pool return line branches outside containment, and both parallel flow paths have one isolation valve outside and one isolation valve inside containment. The suppression pool suction line branches inside containment and each parallel flow path has two isolation valves in series outside containment. It is acceptable to locate both valves outside of containment because an isolation valve inside the drywell would be submerged under water during severe accident conditions.~~

~~All outboard valves are located as close as possible to the containment boundary. The suppression pool suction line arrangement with two outboard valves in series is in accordance with the criteria in SRP 6.2.4 section II.6.d.~~

For details related to FAPCS containment isolation, refer to Subsection 6.2.4.3.2.

Pipes equipped with normally closed manual valves are provided for establishing flow paths from onsite or offsite post-accident water supplies or the Fire Protection System to refill the IC/PCC pools and Spent Fuel Pool following a design basis loss of coolant accident.

Anti-siphoning devices are used on all submerged FAPCS piping to prevent unintended drainage of the pools. The anti-siphoning holes for all FAPCS discharge lines are located at the elevation of normal water level to prevent significant draining of the pool in case of a suction line break at a lower elevation. The anti-siphoning holes in the suction piping of the GDCS Pools and IC/PCC C/C subsystem are located at the elevation of minimum water level to prevent significant draining of the pool in case of a suction line break at a lower elevation. The post-accident makeup lines to the Spent Fuel Pool and IC/PCC Pools are not submerged below the normal water level.

Alternate Shutdown Cooling Mode – This mode may be initiated following an accident for accident recovery. In this mode, FAPCS operates in conjunction with other systems to provide reactor shutdown cooling in the event of loss of other shutdown cooling methods. FAPCS flow path is similar to that of LPCI mode during this mode of operation. Water is drawn from the suppression pool, cooled and then discharged back to the reactor vessel via the LPCI injection flow path. The warmer water in the reactor vessel rises and then overflows into the suppression pool via two opened safety-relief valves on the main steam lines, completing a closed loop for this mode operation.

Drywell Spray Mode - This mode may be initiated following an accident for accident recovery. During this mode of operation, FAPCS draws water from the suppression pool, cools and then spays the cooled water to drywell air space to reduce the containment pressure.

9.1.3.3 Safety Evaluation

The FAPCS is a nonsafety-related system except for the portions of the system that establish flow paths necessary for

- The interface with safety-related RWCU/SDC piping;
- The supply of post-accident makeup water to the Spent Fuel Pool and IC/PCC pools following an accident; and
- The system's containment isolation function. (See Subsection 6.2.4.3.2)

The SFP is designed to dissipate the maximum fuel decay heat through heat up and boiling of the pool water. The most conservative heat load for the SFP occurs when the pool contains spent fuel from 20 years of operation plus one full core offload. The pool water performs the safety-related heat removal function stipulated in GDC 44. Upon loss of power, the Fuel Building HVAC isolates the fuel building as described in Subsection 9.4.2.5. Steam generated by boiling of the SFP is released to the atmosphere through a relief panel in the Fuel Building. Water inventory in the SFP is adequate to keep the fuel covered through 72 hours, thereby avoiding heat up of the fuel and the potential for fission product release. Engineered safety feature atmosphere cleanup systems and associated guidance described in RG 1.52 are not credited by the FAPCS in the ESBWR design as indicated in Subsection 15.4.1.4.1. The Fuel Building does not house any safety-related equipment, subject to flooding, as stated in Subsection 3.4.1.4.3. Sufficient reserve capacity is maintained onsite to extend the safe shutdown state from 72 hours through 7 days ensuring compliance with GDC 61. Post 72-hour inventory makeup is provided via safety-related connections to the Fire Protection System and to offsite water sources.

The FAPCS piping and components that provide the flow paths for the post-accident makeup water supply are designed to meet the requirements contained in Table 9.1-3, Item 3. No active valves are required to operate for establishing post-accident makeup water supply flow paths.

~~Two containment isolation valves are provided on the FAPCS lines that penetrate the containment.~~

~~The use of two containment isolation valves meets NRC GDC 56 requirement. The use of two air-operated outboard containment isolation valves also satisfies GDC 56 based on the allowable exception (Section II.6.d of SRP 6.2.4).~~

~~Containment isolation provisions that differ from the explicit requirements of GDC 56 are acceptable if the basis for the difference is justified. The exception for the suppression pool suction line is quoted in the SRP 6.2.4 Section II.6.d and is acceptable because an inboard valve would be submerged following a severe accident. In order to take credit for this alternate arrangement, the valve closest to containment shall be designed in accordance with SRP Section 3.6.2.~~

~~The containment isolation valves on the suppression pool supply and return lines are fail as is on loss of electric power or the air supply. All other containment isolation valves are fail closed.~~

The Reactor Building and the Fuel Building provide adequate protection against natural phenomena for the safety-related components of the FAPCS as required by GDC 2 and GDC 4.

Safety-related level instrumentation is provided in the spent fuel pool and IC/PCC pools to detect a low water level that would indicate a loss of decay heat removal ability in accordance with GDC 63.

9.1.3.4 Testing and Inspection Requirements

The FAPCS is designed to permit surveillance test and in-service inspection of its safety-related components and components required to perform the post-accident recovery functions, in accordance with GDC 45 and ASME Section XI. The FAPCS is designed to permit leak rate testing of its components required to perform containment isolation function in accordance with 10 CFR 50 Appendix J.

9.1.3.5 Instrumentation and Control

System Instrumentation

Water Levels - The skimmer surge tank level is monitored by a level transmitter mounted on a local panel. The skimmer surge tank level is displayed in the MCR. In addition to level indication, this signal is used to initiate low and high water-level alarms and to operate the Condensate Storage and Transfer System makeup water control valve for the skimmer surge tank.

The IC/PCC pool has two local panel-mounted, safety-related level transmitters for both expansion pools. Both transmitter signals are indicated on the safety-related displays and sent through the gateways for nonsafety-related display and alarms. Both signals are validated and used to control the valve in the makeup water supply line to the IC/PCC pool.

The Spent Fuel Pool has two wide-range safety-related level transmitters that transmit signals to the MCR. These signals are used for water level indication and to initiate high/low-level alarms.

The SFP and IC/PCC pools contain backup nonsafety-related resistive type level indicators that can be operated using portable onsite power supplies to indicate when the pools have been replenished to their normal water level.

All other pools (upper transfer pool, lower fuel transfer pool, cask pool, buffer pool, reactor well, dryer and separator storage pool) have local, nonsafety-related, panel-mounted level transmitters to provide signals for high/low-level alarms in the MCR.

Level instruments for the suppression pool and GDCS pools are provided by other systems.