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August 31, 2011

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attention: Mr. Jeffrey A. Ciocco

Docket No. 52-021
MHI Ref: UAP-HF-11287

Subject: Transmittal of the US-APWR DCD (Revision 3) GSI-191 Tracking Report, (August 2011 Version)

Reference: [1] Letter MHI Ref: UAP-HF-11103 from Y. Ogata (MHI) to the U.S. NRC, "Closure Plan for Issues Associated with GSI-191 for the US-APWR Design Certification", dated May 24, 2011.

[2] Letter MHI Ref: UAP-HF-11247 from Y. Ogata (MHI) to the U.S. NRC, "Transmittal of the US-APWR DCD (Revision 3) GSI-191 Tracking Report, (July 2011 version), dated July 29, 2011.

[3] Letter MHI Ref: UAP-HF-11286 from Y. Ogata (MHI) to the U.S. NRC, "Transmittal of the Technical Report entitled "US-APWR Sump Strainer Performance" (MUAP-08001 Revision 5), dated August 31, 2011.

[4] Letter MHI Ref: UAP-HF-11285 from Y. Ogata (MHI) to the U.S. NRC, "Transmittal of the Technical Report entitled "US-APWR Sump Strainer Downstream Effects" (MUAP-08013 Revision 2), dated August 30, 2011.

[5] Letter MHI Ref: UAP-HF-11280 from Y. Ogata (MHI) to the U.S. NRC, "MHI's Amended Responses to US-APWR DCD RAI 740-5719 Revision 2 (SRP 06.02.02), dated August 31, 2011.

[6] Request for Additional Information No. 815-5986 Revision 3, SRP Section 06.03 – Emergency Core Cooling System Application Section 6.3, dated August 23, 2011.

[7] Letter MHI Ref: UAP-HF-08269 from Y. Ogata (MHI) to the U.S. NRC, "Transmittal of the Technical Report entitled "US-APWR Sump Debris Chemical Effects Test Results" (MUAP-08011-R0), dated November 28, 2008.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") the document entitled "US-APWR DCD (Revision 3) GSI-191 Tracking Report, (August 2011 Version)".

Enclosed is the final DCD GSI-191 Tracking Report (TR) associated with GSI-191 Closure Activities committed to the NRC in Reference 1. The first GSI-191 TR has been submitted for advance staff review in July, 2011 (Reference 2), which did not include changes to

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chapters other than Chapter 6. This letter transmits the final GSI-191 TR which covers all chapters for completeness.

In parallel to this transmittal, MHI submitted following GSI-191 technical reports which will be incorporated by reference to the DCD:

- MUAP-08001-R5 Sump Strainer Performance (Reference 3)
- MUAP-08013-R2 Downstream Effects (Reference 4)

The submittal of these three items is the essential information addressing the US-APWR GSI-191 issues which MHI has committed to amend in Reference 1. MHI requests the NRC to proceed with the review.

There are several ongoing discussion items which the NRC and MHI has been communicated to resolve them to date, however they are not yet mutually agreed. MHI is going to keep the communication with the NRC, through the RAI response, the conference call, the audit, and the public meeting, in order to close these items. The following are the topics and MHI proposals for resolution:

1. The RWSP minimum water level calculation (RAI 740-5719, Reference 5)
   There were several inconsistencies of water inventory between the DCD Revision 3 and MUAP-08001-R4. MHI has cleaned up them and prepared the final GSI-191 TR and MUAP-08001-R5 for consistency. MHI amended the RAI response (Reference 5) and will support the NRC audit for the review.

2. The delay time for debris reaching the RWSP (RAI 815-5986, Reference 6)
   A new RAI was issued by the NRC on August 23, 2011 with regard to the potential non-conservatisms of time delay analysis for debris transport discussed in MUAP-08013-R1 Appendix E. MHI is going to response to the RAI within 30 days from RAI issuance and will support the NRC audit if needed.

3. Post-LOCA RWSP temperature profile
   A confirmatory item has been identified by the staff with regard to the RWSP water temperature profile used in the US-APWR chemical effects test. (Reference 7) MHI will confirm if the water temperature profile used in the tests is still conservative in terms of chemical dissolution, comparing with the calculated RWSP water temperature profile amended after the tests. If needed, MHI will submit a mark-up to supplement the information in the chemical effects test report. (Reference 7)

4. Potential staff concerns about Ex-vessel issue
   A conference call with staff was held on August 18, 2011 and discussed ex-vessel issue prepared in MUAP-08013-R1. During the call, the NRC implied that additional RAI might be issued very soon. MHI requests the NRC to issue the RAI so that MHI could take immediate actions for resolution the concerns.

Lastly, this report is independent from the standard Tracking Reports submitted periodically to the NRC, which include comprehensive changes to all chapters. The

proposed changes included in this report will be consolidated into the next revision of the standard Tracking Reports.

Please contact Dr. C. Keith Paulson, Senior Technical Manager, Mitsubishi Nuclear Energy Systems, Inc. if the NRC has questions concerning any aspect of the submittals. His contact information is below.

Sincerely,

Yoshiki Ogata,
General Manager- APWR Promoting Department
Mitsubishi Heavy Industries, LTD.

Enclosures:

1. US-APWR DCD (Revision 3) GSI-191 Tracking Report, (August 2011 Version)

CC: J. A. Ciocco
C. K. Paulson

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Docket No. 52-021
MHI Ref: UAP-HF-11287

Enclosure 1

UAP-HF-11287
Docket No. 52-021

US-APWR DCD (Revision 3)

GSI-191 Tracking Report

Proposed Changes for GSI-191 Closure Activities

(August 2011 Version)

This is the final DCD GSI-191 Tracking Report (TR) associated with GSI-191 Closure Activities committed to in MHI Letter UAP-HF-11103 dated May 24, 2011. This report is independent from the standard Tracking Reports submitted periodically to the NRC, which include comprehensive changes to all chapters. The proposed changes included in this report will eventually be consolidated into the standard Tracking Reports.

The first GSI-191 TR was submitted in MHI Letter UAP-HF-11247 dated July 29, 2011, to prepare the required sump strainer design information in the DCD Chapter 6. The final GSI-191 TR, which covers all chapters for completeness, is submitted as follows.

Tier 1

Section 2.0 Design Description and ITAAC

Tier 1 Change List

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.T1-00001	Tier 1 2.4.4 Table 2.4.4-5 (Sheet 6 of 10) ITAAC item 7.b.iv	2.4-51	Updated by final design information of the strainer	Acceptance criteria of the minimum strainer surface area is replaced with "2,730 ft^2 per sump", which is reduced by tolerance from nominal surface area 2,754 ft^2.	-
DCD_06.02.02-38	Tier 1 Figure 2.4.4-1	2.4-60	Response to RAI No. 354 MHI Letter No. UAP-HF-09365 Date 07/07/2009	Add the wording, "(one of 10 pcs)." (Clean-up item)	-

Tier 2

Chapter 1

Chapter 1 Change List

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.01-00001	Table 1.6-1 Material reference	1.6-2	Clarification	Add technical reports associated with GSI-191 as IBR.	-
RAI 06.02.02-35	Table 1.8-1	1.8-20	Clarification	COL6.2(5) is updated to contain design basis limits of latent debris and miscellaneous debris in containment.	-
MIC-03.01-00002	Table 1.8-1	1.8-20	Clarification	COL6.2(6) is added to control the use of insulation in containment for consistency with those quantities used for safety evaluation.	-
MIC-03.01-00003	Table 1.9.1-1 (Sheet 8 of 20) RG 1.82	1.9-10	Editorial correction	Reference subsection should be correctly read as "6.2.2.2.6 and 6.2.2.3".	-
MIC-03.01-00004	Table 1.9.3-1 (Sheet 24 to 29 of 29) GSI-191	1.9-408	Clarification	Remove redundant description. Instead, add summary of conformance with GSI-191 as well as RG 1.82R3.	-

Tier 2

Chapter 5

Chapter 5 Change List

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.05-00001	Table 5.4.7-2 (Sheet 1 of 2)	5.4-57	Clarification	Update NPSH calculation of CS/RHR pump	-
MIC-03.05-00002	5.2.7 Reference	5.2-48	Editorial correction	Refer latest revision of the document, MUAP-08001-R5.	-

Tier 2

Chapter 6

Chapter 6 Change List

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
~~DCD_06.02.02-63~~	~~6.1.1.2.1~~ ~~6.2.2.3~~	~~6.1-3~~ ~~6.2-48~~	~~Response to RAI No. 736~~ ~~MHI Letter No. UAP-HF-11185~~ ~~Date 06/21/2011~~	~~Added "Programmatic controls to limit aluminum in the containment are described in Subsection 6.2.2.1." in Section 6.1.1.2.1.~~ ~~Added ", aluminum" in Section 6.2.2.3.~~ This is superseded by below. (See next row.)	-
DCD_06.02.02-63	6.1.1.2.3 6.2.2.3	6.1-5 6.2-48	Amended response to RAI No. 736 MHI Letter No. UAP-HF-11215 Date 07/13/2011	Added "Programmatic controls to limit aluminum in the containment are described in Subsection 6.2.2.3." in Section 6.1.1.2.1. Added ", aluminum" in Section 6.2.2.3.	-
MIC-03.06-00001	6.2.2.2.5	6.2-45	Clarification	Replaced RWSP operating temperature with the design temperature of 270°F for consistency with Section 6.2.1.1.2 and to bound the peak LOCA fluid temperature.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00002	6.2.2.2.5	6.2-45	Clarification and errata	Re-worded and corrected typos in description of debris size and transportability. Added reference to Figure 6.2.1-12.	-
MIC-03.06-00003	6.2.2.2.5	6.4-45	Clarification	Re-worded to state that strainers satisfy the Safety Evaluation (SE) of NEI 04-07.	-
MIC-03.06-00004	6.2.2.2.6	6.2-46	Clarification	Revised in entirety to describe additional strainer design details and design consistency with RG 1.82.	-
MIC-03.06-00005	6.2.2.3	6.2-47	Clarification	Deleted existing GSI-191 program descriptions, which are replaced by content in newly created sections.	-
DCD_06.02.02-55	6.2.2.3.1	6.2-47	GSI-191, Break Selection	Added section to describe break selection criteria.	-
DCD_06.02.02-55	6.2.2.3.2	6.2-48	GSI-191, Debris Source Term	Added section to describe design-basis debris source term, insulation types, and attachment methods.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00006	6.2.2.3.2	6.2-48 6.2-49 6.2-50	Clarification and errata	Re-worded for clarity, elaborated, and corrected typos in description of programmatic controls for debris sources.	-
DCD_06.02.02-55	6.2.2.3.3	6.2-50	GSI-191, Debris Generation	Added new section and updated methodology to describe debris generation and ZOIs.	-
DCD_06.02.02-55	6.2.2.3.4	6.2-50	GSI-191, Debris Characteristics	Added section to describe debris transportability characteristics.	-
DCD_06.02.02-55	6.2.2.3.5	6.2-50	GSI-191, Debris Transport	Added section to describe debris transport to strainer.	-
DCD_06.02.02-55	6.2.2.3.6	6.2-50	GSI-191, Debris Head Loss	Added section to provide design-basis strainer head loss and refer to head loss tests.	-
DCD_06.02.02-55	6.2.2.3.7	6.2-50	GSI-191, NPSH	Added section to describe NPSH calculation.	-
DCD_06.02.02-55	6.2.2.3.8	6.2-50	GSI-191, Thermo-hydraulic performance	Added section to describe air ingestion on strainer performance (e.g., vortex, flashing, deaeration).	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
DCD_06.02.02-55	6.2.2.3.9	6.2-50	GSI-191, Coatings	Added section to describe coating qualification and standards.	-
DCD_06.02.02-55	6.2.2.3.10	6.2-50	GSI-191, Chemical debris	Added section to describe chemical precipitates and tests.	-
DCD_06.02.02-55	6.2.2.3.11	6.2-50	GSI-191, Upstream effects	Added section to describe return water and flow path blockage to RWSP.	-
DCD_06.02.02-55	6.2.2.3.12	6.2-50	GSI-191, Downstream effects	Added section to describe ex-vessel (component and equipment) performance downstream of strainer.	-
DCD_06.02.02-55	6.2.2.3.13	6.2-50	GSI-191, Downstream effects	Added section to describe in-vessel (core blockage) performance downstream of strainer.	-
DCD_06.02.02-55	6.2.2.3.14	6.2-50	GSI-191, Sump Structural Analysis	Added section to describe sump strainer structural analysis.	-
MIC-03.06-00007	6.2.8	6.2-67	Clarification	COL6.2(5) was revised to provide quantitative limits of latent debris.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00008	6.2.8	6.2-67	Clarification	COL6.2(6) was added to state that the procedure will be required to ensure the insulations used in the containment is consistent with debris basis.	
MIC-03.06-00009	6.2.9	6.2-69	Clarification	Revised Ref. 6.2-24 to include Safety Evaluation of NEI 04-07.	-
DCD_06.02.02-55	6.2.9	6.2-70	GSI-191, References	Added additional references for revisions and new content to address GSI-191.	-
DCD_06.02.02-64	Table 6.2.1-3 Table 6.2.1-5 (Sheet 1 of 2)	6.2-73 6.2-75	Amended Response to RAI No. 740 MHI Letter No. UAP-HF-11[TBD]	Revised Table 6.2.1-3 and 6.2.1-5 (Sheet 1 of 2) to reasons as discussed in RAI 740-5719.	-
MIC-03.06-00010	Table 6.2.2-1	6.2-170	Clarification	Update NPSH calculation based on the design basis strainer head loss.	-
MIC-03.06-00011	Table 6.2.2-2 (Sheet 2 of 17) Regulatory position 1.1.1.3	6.2-172	Clarification	Update the US-APWR design information consistent with the regulatory position.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00012	Table 6.2.2-2 (Sheet 2 of 17) Regulatory position 1.1.1.4	6.2-172	Clarification	Update the US-APWR design information consistent with the regulatory position.	-
MIC-03.06-00013	Table 6.2.2-2 (Sheet 4 of 17) Regulatory position 1.1.1.7	6.2-174	Clarification	Update the US-APWR design information consistent with the regulatory position.	-
MIC-03.06-00014	Table 6.2.2-2 (Sheet 4 of 17) Regulatory position 1.1.1.11	6.2-174	Editorial correction	Replaced the wording "RWSP suction strainer" with "ECC/CS strainer".	-
			Clarification	Updated the US-APWR design information consistent with the regulatory position.	-
MIC-03.06-00015	Table 6.2.2-2 (Sheet 5 of 17) Regulatory position 1.1.1.12	6.2-175	Editorial correction	Replaced the wording "RWSP suction strainer" with "ECC/CS strainer".	-
			Clarification	Add information to address the consistency of the design with the Regulatory Position.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00016	Table 6.2.2-2 (Sheet 5 of 17) Regulatory position 1.1.1.13	6.2-175	Clarification	Remove previous strainer design information. Add statements for consistency with the regulatory position.	-
MIC-03.06-00017	Table 6.2.2-2 (Sheet 5 of 17) Regulatory position 1.1.1.14	6.2-175	Editorial correction	Replaced the wording "RWSP suction strainer" with "ECC/CS strainer".	-
MIC-03.06-00018	Table 6.2.2-2 (Sheet 6 of 17) Regulatory position 1.1.1.15	6.2-176	Editorial correction	Replaced the wording "planned" with "applied'.	-
			Clarification	Add information to address the consistency of the strainer design with regulatory position.	-
MIC-03.06-00019	Table 6.2.2-2 (Sheet 6 of 17) Regulatory position 1.1.2.2	6.2-176	Clarification	Replaced with the latest debris source term information. Add programmatic control during maintenance.	-
MIC-03.06-00020	Table 6.2.2-2 (Sheet 6 of 17) Regulatory position 1.1.2.3	6.2-176	Clarification	Add programmatic control information to minimize the use of aluminum in containment.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00021	Table 6.2.2-2 (Sheet 6 of 17) Regulatory position 1.1.3	6.2-177	Clarification	Add statement that the US-APWR does not reply on operator action against debris accumulation on the strainer.	-
MIC-03.06-00022	Table 6.2.2-2 (Sheet 7 of 17) Regulatory position 1.1.4	6.2-177	Erratum	"Appendix-5" was correctly read as "Appendix-B" per RG 1.82 statement.	-
MIC-03.06-00023	Table 6.2.2-2 (Sheet 7 of 17) Regulatory position 1.1.5	6.2-177	Editorial correction	Replaced the wording "RWSP suction strainer" with "ECC/CS strainer".	-
MIC-03.06-00024	Table 6.2.2-2 (Sheet 8 of 17) Regulatory position 1.2	6.2-178	Erratum	"Regulatory Position 3.1" was correctly read as "Regulatory Position 1.3"	-
			Editorial correction	Replaced the wording "RWSP suction strainer" with "ECC/CS strainer". (Typical two places)	-
MIC-03.06-00025	Table 6.2.2-2 (Sheet 8 of 17) Regulatory position 1.3	6.2-178	Editorial correction	"NEI 04-07" was correctly referred as "the SE of NEI 04-07"	-
			Clarification	Replaced with the statement to refer precise subsections and technical reports for compliance with the regulatory position.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00026	Table 6.2.2-2 (Sheet 9 of 17) Regulatory position 1.3.1.1.	6.2-179	Erratum	"Regulatory Position 3.1.2" was correctly read as "Regulatory Position 1.3.1.2"	-
MIC-03.06-00027	Table 6.2.2-2 (Sheet 9 of 17) Regulatory position 1.3.1.2.	6.2-179	Erratum	"Regulatory Position 3.1.1" was correctly read as "Regulatory Position 1.3.1.1"	-
MIC-03.06-00028	Table 6.2.2-2 (Sheet 9 of 17) (Sheet 10 of 17) (Sheet 11 of 17)	6.2-179 6.2-180 6.2-181	Editorial correction	The table rows, 1.3.1.3 to 1.3.1.6, were moved from page 6.2-180 and 6.2-181, and inserted between 1.3.1.2 and 1.3.1.7	-
MIC-03.06-00029	Table 6.2.2-2 (Sheet 9 of 17) Regulatory position 1.3.1.8.	6.2-179	Erratum	"Regulatory Position 3.4" was correctly read as "Regulatory Position 1.3.4". (Typical two places.)	-
MIC-03.06-00030	Table 6.2.2-2 (Sheet 10 of 17) Regulatory position 1.3.1.9	6.2-180	Editorial correction	"NEI 04-07" was correctly referred as "the SE of NEI 04-07"	-
			Clarification	Replaced with the statement to refer precise subsections and technical reports for compliance with the regulatory position 1.3.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00031	Table 6.2.2-2 (Sheet 12 of 17) Regulatory position 1.3.2.2	6.2-182	Clarification	Add to state that ZOI(s) based of SE of NEI-04-07 were utilized. Add to refer NRC letter for the use of reduced ZOI for protective coating. Replaced with the statement to refer precise subsections and technical reports for compliance with the regulatory position.	-
MIC-03.06-00032	Table 6.2.2-2 (Sheet 12 of 17) (Sheer 13 of 17) (Sheet 14 of 17)	6.2-182 6.2-183 6.2-184	Editorial correction	The table rows, 1.3.1.3 to 1.3.1.6, were moved from page 6.2-180 and 6.2-181, and inserted between 1.3.1.2 and 1.3.1.7.	-
MIC-03.06-00033	Table 6.2.2-2 (Sheet 13 of 17) Regulatory position 1.3.2.6	6.2-183	Clarification	Address contrastively with regulatory position how chemical debris was considered in the US-APWR design.	-
MIC-03.06-00034	Table 6.2.2-2 (Sheet 13 of 17) Regulatory	6.2-183	Clarification	Address contrastively with regulatory position regarding debris degradation in	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
	position 1.3.2.7			the analysis.	
MIC-03.06-00035	Table 6.2.2-2 (Sheet 13 of 17) Regulatory position 1.3.2.3	6.2-183	Clarification	Add to state that ZOI(s) based of SE of NEI-04-07 were utilized, and state to refer precise subsection for compliance with the regulatory position.	-
MIC-03.06-00036	Table 6.2.2-2 (Sheet 14 of 17) Regulatory position 1.3.2.4	6.2-184	Clarification	Add statement to refer precise subsection for compliance with the regulatory position.	-
MIC-03.06-00037	Table 6.2.2-2 (Sheet 14 of 17) Regulatory position 1.3.3.1.	6.2-184	Clarification	Replace with updated clarification for debris transport analysis.	-
MIC-03.06-00038	Table 6.2.2-2 (Sheet 14 of 17) Regulatory position 1.3.3.2.	6.2-184	Clarification	Summarize debris type and erosion used in transport analysis.	-
MIC-03.06-00039	Table 6.2.2-2 (Sheet 14 of 17) Regulatory	6.2-184	Clarification	Address that CFD was not utilized for the US-APWR debris transport analysis.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
	position 1.3.3.3.				
MIC-03.06-00040	Table 6.2.2-2 (Sheet 15 of 17) Regulatory position 1.3.3.4.	6.2-185	Clarification	Address that CFD was not utilized for the US-APWR debris transport analysis.	-
MIC-03.06-00041	Table 6.2.2-2 (Sheet 15 of 17) Regulatory position 1.3.3.5.	6.2-185	Clarification	Address that curbs on the RWSP floor was not credited to reduce the transportable debris to the strainer.	-
MIC-03.06-00042	Table 6.2.2-2 (Sheet 15 of 17) Regulatory position 1.3.3.6.	6.2-185	Clarification	Summarize that all debris in the pool was assumed transportable.	-
MIC-03.06-00043	Table 6.2.2-2 (Sheet 15 of 17) Regulatory position 1.3.3.8.	6.2-185	Editorial correction	"Regulatory Position 3.3.4" was correctly read as "Regulatory Position 1.3.3.4"	-
			Clarification	Replaced with the summary of debris transport and addressed that potential choke	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
				points has been surveyed and assessed in the evaluation.	
MIC-03.06-00044	Table 6.2.2-2 (Sheet 16 of 17) Regulatory position 1.3.3.9.	6.2-186	Editorial correction	Replaced the wording "RWSP suction strainer" with "ECC/CS strainer".	-
			Clarification	Address contrastively with regulatory position that floating debris doe not adverse strainer design.	-
MIC-03.06-00045	Table 6.2.2-2 (Sheet 16 of 17) Regulatory position 1.3.4.1.	6.2-186	Clarification	Replaced with the statement regarding assumptions utilized for strainer performance evaluation.	-
MIC-03.06-00046	Table 6.2.2-2 (Sheet 16 of 17) Regulatory position 1.3.4.2.	6.2-186	Clarification	Address contrastively with regulatory position regarding uniform debris accumulation on the strainer which has been demonstrated by testing.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00047	Table 6.2.2-2 (Sheet 16 of 17) Regulatory position 1.3.4.3.	6.2-186	Clarification	Replaced with the statement regarding assumptions utilized for strainer performance evaluation.	-
MIC-03.06-00048	Table 6.2.2-2 (Sheet 16 of 17) Regulatory position 1.3.4.4.	6.2-186	Editorial correction	Inserted "the" before "US-APWR". Replaced the wording "RWSP suction strainer" with "ECC/CS strainer". Delete submergence value (i.e. 4ft) from the statement.	-
MIC-03.06-00049	Table 6.2.2-2 (Sheet 17 of 17) Regulatory position 1.3.4.5.	6.2-187	Clarification	Replaced with statement how design basis head loss was determined with a sufficient margin to empirical data obtained from strainer testing which was performed debris accumulation without unobstructed portion.	-
MIC-03.06-00050	Table 6.2.2-2 (Sheet 17 of 17) Regulatory position 1.3.4.6.	6.2-187	Clarification	Replaced with statement how design basis head loss was determined with a sufficient margin to empirical data obtained from strainer testing which was implemented	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
				under different debris combinations.	
DCD_06.02.02-55	Table 6.2.2-4	[TBD]	GSI-191, Design Basis Debris	Added new table to describe design-basis debris for strainer performance evaluation.	-
MIC-03.06-00051	6.3.2.2.3 "Refueling water storage pit" 2nd paragraph, last sentence	6.3-7	Editorial correction	The RWSP peak temperature was corrected as 270F, which is consistent with the correction in subsection 6.2.2.2.5.	-
MIC-03.06-00052	6.3.2.2.4 "ECC/CS strainer" 3rd paragraph, last sentence	6.3-8	Erratum	"Subsection 6.2.2.26" was correctly read as "Subsection 6.2.2.2.6"	-
MIC-03.06-00053	6.3.2.2.4 "ECC/CS strainer" 4th paragraph, 1st sentence	6.3-8	Editorial correction	"NEI 04-07" was correctly referred as "the SE of NEI 04-07"	-
MIC-03.06-00054	Table 6.3-2 USI A-43	6.3-31	Clarification	Add statement to refer new subsection for addressing Unresolved Safety Issue A-43.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00055	Table 6.3-3 GSI-191	6.3-33	Clarification	Add statement to refer new subsection for addressing GSI-191.	-
MIC-03.06-00056	Table 6.3-4 GL 98-04	6.3-39	Clarification	Add statement to refer new subsections for addressing GL 98-04.	-
MIC-03.06-00057	Table 6.3-4 BL 93-02	6.3-41	Clarification	Add statement to refer new subsection for addressing BL 93-02.	-
MIC-03.06-00058	Table 6.3-4 BL 95-02	6.3-41	Clarification	Add statement to refer new subsection for addressing BL 95-02.	-
MIC-03.06-00059	Table 6.3-4 BL 96-03	6.3-42	Clarification	Add statement to refer new subsection for addressing BL 96-03.	-
MIC-03.06-00060	Table 6.3-4 GL 2004-02	6.3-43	Editorial correction	Delete referred technical reports from the Table 6.3-4.	-
MIC-03.06-00061	Table 6.3-4 BL 2003-01	6.3-44	Editorial correction	Delete referred technical reports from the Table 6.3-4.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00062	Table 6.3-5 ECC/CS strainer (Sheet 1 of 3)	6.3-45	Clarification	Updated strainer surface area per train (i.e., 2,754ft^2) Updated design basis debris head loss. (4.0 ft at 120F)	-
MIC-03.06-00063	Table 6.3-5 ECC/CS strainer (Sheet 1 of 3)	6.3-45	Clarification	Updated NPSH available and Design basis NPSH required.	-
MIC-03.06-00064	Table 6.3-5 ECC/CS strainer (Sheet 2 of 3)	6.3-46	Clarification	Add Note 3.	-
MIC-03.06-00065	Table 6.3-5 RWSP (Sheet 3 of 3)	6.3-47	Clarification	Updated the design temperature of TWSP and calculated peak temperature.	-

*Page numbers for the attached marked-up pages may differ from the revision 3 page numbers due to text additions and deletions. When the page numbers for the attached pages do differ, the page number for the attached page is shown in brackets.

Tier 2

Chapter 14

Chapter 14 Change List

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.14-00001	Table 14.3-1a (Sheet 2 of 8)	14.3-32	Editorial correction	Alternatively refer precise subsection 6.2.2.2.6 and 6.2.3 for strainer information.	-

*Page numbers for the attached marked-up pages may differ from the revision 3 page numbers due to text additions and deletions. When the page numbers for the attached pages do differ, the page number for the attached page is shown in brackets.

Tier 2

Chapter 16

Chapter 16 Change List

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
DCD_06.02.02-64	3.5.4 RWSP SR 3.5.4.2	3.5.4-2	Amended Response to RAI No. 740 MHI Letter No. UAP-HF-11XXX	RWSP minimum water volume was updated to be consistent with Table 6.2.1-3.	-

*Page numbers for the attached marked-up pages may differ from the revision 3 page numbers due to text additions and deletions. When the page numbers for the attached pages do differ, the page number for the attached page is shown in brackets.

Tier 2

Chapter 19

Chapter 19 Change List

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.19-00001	19.1.7.1	19.1-180	Clarification	Add last paragraph to discuss PRA evaluation for crediting containment pressure in determining available NPSH of safety pumps.	-
MIC-03.19-00002	19.1.7.5	19.1-181	Clarification	Add a bullet to address the minimal contribution to plant risk due to crediting containment pressure in NPSH calculation.	-

*Page numbers for the attached marked-up pages may differ from the revision 3 page numbers due to text additions and deletions. When the page numbers for the attached pages do differ, the page number for the attached page is shown in brackets.

Tier-1

2.4 Emergency Core Cooling System

2.4.4 Emergency Core Cooling System (ECCS)

2.4.4.1 Design Description

The primary purpose of the ECCS is to remove stored energy and fission product decay heat from the reactor core following an accident. Four important functions of this safety-related system are to ensure that (1) fuel cladding temperature, oxidation and hydrogen production limits are not exceeded, (2) "coolable" core geometry is maintained, (3) long-term core cooling is available, and (4) the ECCS is capable of providing the containment isolation function, as described in Section 2.11.2, for piping penetrating the containment.

In combination with control rod insertion, the ECCS is designed to shut down and cool the reactor during the following accidents:

- LOCAs,
- Ejection of a control rod cluster assembly,
- Secondary steam system piping failure,
- Inadvertent operating of main steam relief or safety valve, and
- Steam generator tube failure.

The ECCS includes four 50%-capacity safety injection pump divisions.

The ECCS has the following functions:

Accumulator injection - The accumulator system stores borated water under pressure and automatically injects it into the RCS if the reactor coolant pressure decreases below the accumulator pressure.

High head injection - The high-head injection system takes suction from the RWSP and delivers borated water to the safety injection nozzles on the reactor vessel or to the hot legs of the RCS.

Emergency letdown - The emergency letdown system can be utilized to achieve a cold shutdown boration level in the RCS by directing reactor coolant to the RWSP and providing borated water from the RWSP to the RCS via the safety injection pumps.

Containment pH control - Sodium tetraborate decahydrate (NaTB) contained in baskets provides adjustment of the pH of the water in the containment following an accident. The pH adjustment maintains the desired post-accident pH conditions in the containment water, to enhance the iodine retention capacity in the containment and to avoid stress corrosion cracking of the austenitic stainless steel components.

1.a The functional arrangement of the ECCS is as described in the Design Description of Subsection 2.4.4.1 and in Table 2.4.4-1 and as shown in Figure 2.4.4-1.

1.b Each mechanical division of the ECCS (Divisions A, B, C & D) is physically separated from the other divisions, with the exception of inside the containment, so as not to preclude accomplishment of the safety function.

2.a.i The ASME Code Section III components of the ECCS identified in Table 2.4.4-2 are fabricated, installed and inspected in accordance with ASME Code Section III requirements.

2.a.ii The ASME Code Section III components of the ECCS identified in Table 2.4.4-2 are reconciled with the design requirements.

2.b.i The ASME Code Section III piping of the ECCS, including supports, identified in Table 2.4.4-3, is fabricated, installed, and inspected in accordance with ASME Code Section III requirements.

2.b.ii The ASME Code Section III piping of the ECCS, including supports, identified in Table 2.4.4-3, is reconciled with the design requirements.

3.a Pressure boundary welds in ASME Code Section III components, identified in Table 2.4.4-2, meet ASME Code Section III requirements for non-destructive examination of welds.

3.b Pressure boundary welds in ASME Code Section III piping, identified in Table 2.4.4-3, meet ASME Code Section III requirements for non-destructive examination of welds.

4.a The ASME Code Section III components, identified in Table 2.4.4-2, retain their pressure boundary integrity at their design pressure.

4.b The ASME Code Section III piping, identified in Table 2.4.4-3, retains its pressure boundary integrity at its design pressure.

5.a The seismic Category I equipment, identified in Table 2.4.4-2, can withstand seismic design basis loads without loss of safety function.

5.b The seismic Category I piping, including supports, identified in Table 2.4.4-3 can withstand seismic design basis loads without a loss of its safety function.

6.a The Class 1E equipment identified in Table 2.4.4-2 as being qualified for a harsh environment can withstand the environmental conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function.

6.b Class 1E equipment, identified in Table 2.4.4-2, is powered from its respective Class 1E division.

6.c Separation is provided between redundant divisions of ECCS Class 1E cables, and between Class 1E cables and non-Class 1E cables.

7.a Deleted.

7.b The ECCS provides RCS makeup, boration, and safety injection during design basis events.

7.c The ECCS provides pH adjustment of water flooding the containment following design basis accidents.

7.d The safety injection pumps have sufficient net positive suction head (NPSH).

8. Controls are provided in the MCR to open and close the remotely operated valves identified in Table 2.4.4-2.

9.a The motor-operated, air-operated and check valves, identified in Table 2.4.4-2 as having an active safety function, perform an active safety function to change position as indicated in the table.

9.b After loss of motive power, the remotely operated valves, identified in Table 2.4.4-2, assume the indicated loss of motive power position.

10.a Controls are provided in the MCR to start and stop the safety injection pumps identified in Table 2.4.4-4.

10.b The pumps identified in Table 2.4.4-4 start after receiving an ECCS actuation signal.

10.c A confirmatory-open interlock is provided to automatically open the accumulator discharge valve upon the receipt of an ECCS actuation signal or an above low pressurizer pressure (P11) setpoint signal.

11. Alarms and displays identified in Table 2.4.4-4 are provided in the MCR.

12. Alarms, displays and controls identified in Table 2.4.4-4 are provided in the RSC.

13. The piping identified in Table 2.4.4-3 as designed for LBB meets the LBB criteria, or an evaluation is performed of the protection from the dynamic effects of a rupture of the line.

14.a Deleted

14.b Deleted

2.4.4.2 Inspections, Tests, Analyses, and Acceptance Criteria

Table 2.4.4-5 describes the ITAAC for the ECCS.

The ITAAC associated with the ECCS equipment, components, and piping that comprise a portion of the CIS are described in Table 2.11.2-2.

Table 2.4.4-1 Emergency Core Cooling System Location of Equipment and Piping

System and Components	Location
ECC/CS Suction Strainers	Containment
Safety injection pumps	Reactor Building
Accumulators	Containment
Refueling Water Storage Pit	Containment
NaTB Baskets	Containment
NaTB Basket Containers	Containment
Safety injection piping and valves between the direct vessel injection penetration and including the check valve SIS-VLV-012 A, B, C, D upstream of the direct vessel injection penetration	Containment
Safety injection piping and valves upstream of and excluding the check valve SIS-VLV-012A,B,C,D upstream of the direct vessel injection penetration	Containment and Reactor Building
Hot leg injection piping downstream of and including the motor operated valves SIS-MOV-014 A ,B, C, D	Containment
Hot leg injection piping upstream of but excluding the motor operated valves SIS-MOV-014 A, B, C, D	Containment
Accumulator piping and valves on the RCS side of and including the check valves SIS-VLV-102 A, B, C, D	Containment
Accumulator piping and valves on the accumulator side of but excluding the check valves SIS-VLV-102 A, B, C, D	Containment
Emergency letdown isolation valves SIS-MOV-031A, 031D, 032A, 032D and piping between valves	Containment
Accumulator nitrogen vent piping up and including valves SIS-VLV-114, SIS-MOV-121A,B	Containment and Reactor Building
NaTB solution transfer piping	Containment
RWSP transfer piping	Containment
Refueling cavity drain piping	Containment

Table 2.4.4-2 Emergency Core Cooling System Equipment Characteristics (Sheet 1 of 4)

Equipment Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	PSMS Control	Active Safety Function	Loss of Motive Power Position
ECC/CS Strainers	SIS-SST-001 A, B, C, D	-	Yes	-	-/-	-	-	-
Safety Injection Pumps	SIS-MPP-001 A, B, C, D	2	Yes	-	Yes/No	ECCS Actuation	Start	-
Accumulators	SIS-MTK-001 A, B, C, D	2	Yes	-	-	-	-	-
Refueling Storage Water Pit	RWS-MCT-001	-	Yes	-	-	-	-	-
NaTB Baskets	PHS-MEQ-001A~Y	-	Yes	-	-	-	-	-
NaTB Basket Containers	PHS-MTK-001A,B,C	2	Yes	-	-	-	-	-
Safety Injection Pump Suction Isolation Valves	SIS-MOV-001 A, B, C, D	2	Yes	Yes	Yes/ Yes	Remote Manual	Transfer Closed	As Is
Safety Injection Pump Discharge Containment Isolation Valves	SIS-MOV-009 A, B, C, D	2	Yes	Yes	Yes/ No	Remote Manual	Transfer Closed	As Is
Safety Injection Pump Discharge Containment Isolation Check Valves	SIS-VLV-010 A, B, C, D	2	Yes	-	-/-	-	Transfer Open/ Transfer Closed	-

Table 2.4.4-2 Emergency Core Cooling System Equipment Characteristics (Sheet 2 of 4)

Equipment Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	PSMS Control	Active Safety Function	Loss of Motive Power Position
Direct Vessel Safety Injection Line Isolation Valves	SIS-MOV-011 A, B, C, D	2	Yes	Yes	Yes/ Yes	Remote Manual	Transfer Open/ Transfer Closed	As Is
Hot Leg Injection Isolation Valves	SIS-MOV-014 A, B, C, D	1	Yes	Yes	Yes/ Yes	Remote Manual	Transfer Open	As Is
Hot Leg Injection Check Valves	SIS-VLV-015 A, B, C, D	1	Yes	-	-/-	-	Transfer Open	-
Accumulator Discharge Valves	SIS-MOV-101 A, B, C, D	2	Yes	Yes	Yes/ Yes	ECCS Actuation, Above Low Pressureizer Pressure (P11) Setpoint	Transfer Open	As Is
						Remote Manual	Transfer Closed	
Accumulator Nitrogen Supply Line Isolation Valves	SIS-MOV-125 A, B, C, D	2	Yes	Yes	Yes/ Yes	Remote Manual	Transfer Open	As Is
Accumulator Nitrogen Discharge Valves	SIS-MOV-121 A, B	2	Yes	Yes	Yes/ Yes	Remote Manual	Transfer Open	As Is

Table 2.4.4-2 Emergency Core Cooling System Equipment Characteristics (Sheet 3 of 4)

Equipment Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	PSMS Control	Active Safety Function	Loss of Motive Power Position
Accumulator Nitrogen Supply Containment Isolation Valve	SIS-AOV-114	2	Yes	Yes	Yes/No	Containment Isolation	Transfer Closed	Closed
Accumulator Nitrogen Supply Containment Isolation Check Valve	SIS-VLV-115	2	Yes	-	-/-	-	Transfer Closed	-
Accumulator Injection Line 1st Check Valves	SIS-VLV-102 A, B, C, D	1	Yes	No	-	-	Transfer Open	-
Accumulator Injection Line 2nd Check Valves	SIS-VLV-103 A, B, C, D	1	Yes	No	-	-	Transfer Open	-
Direct Vessel Injection Line 1st Check Valves	SIS-VLV-012 A, B, C, D	1	Yes	No	-	-	Transfer Open	-
Direct Vessel Injection Line 2nd Check Valves	SIS-VLV-013 A, B, C, D	1	Yes	No	-	-	Transfer Open	-
Emergency Letdown Line 1st Isolation Valves	SIS-MOV-031 A, D	1	Yes	Yes	Yes/ Yes	Remote Manual	Transfer Open/ Transfer Closed	As Is
Emergency Letdown Line 2nd Isolation Valves	SIS-MOV-032 A, D	1	Yes	Yes	Yes/ Yes	Remote Manual	Transfer Open/ Transfer Closed	As Is

Table 2.4.4-2 Emergency Core Cooling System Equipment Characteristics (Sheet 4 of 4)

Equipment Name	Tag No.	ASME Code Section III Class	Seismic Category I	Remotely Operated Valve	Class 1E/ Qual. For Harsh Envir.	PSMS Control	Active Safety Function	Loss of Motive Power Position
Safety Injection Pump Discharge Check Valves	SIS-VLV-004 A,B,C,D	2	Yes	No	—	—	Transfer Open	—
Safety Injection Pump Minimum Flow	SIS-FT-072, 073, 074, 075	—	Yes	—	Yes/No	—	—	—
Accumulator Water Level	SIS-LT-010, 020, 030,040	—	Yes	—	Yes/Yes	—	—	—
Accumulator Pressure	SIS-PT-010, 020, 030, 040	—	Yes	—	Yes/Yes	—	—	—
Safety Injection Pump Suction Pressure	SIS-PT-060, 061, 062, 063	—	Yes	—	Yes/No	—	—	—
Safety Injection Pump Discharge Pressure	SIS-PT-064, 065, 066, 067	—	Yes	—	Yes/No	—	—	—
Refueling Water Storage Pit Water Level	RWS-LT-010, 011, 012, 013	—	Yes	—	Yes/Yes	—	—	—
Safety Injection Pump Discharge Flow	SIS-FT-062, 063, 064, 065	—	Yes	—	Yes/No	—	—	—

NOTE:
Dash (-) indicates not applicable

Table 2.4.4-3 Emergency Core Cooling System Piping Characteristics

Pipe Line Name	ASME Code Section III Class	Leak Before Break	Seismic Category I
SI piping and valves between the DVI penetration and including the check valve SIS-VLV-012 A, B, C, D upstream of the DVI penetration	1	No	Yes
SI piping and valves upstream of and excluding the check valve SIS-VLV-012 A, B, C, D upstream of the DVI penetration	2	No	Yes
Hot leg injection piping downstream of and including the 4 motor operated valves SIS-MOV-014 A, B, C, D	1	No	Yes
Hot leg injection piping upstream of but excluding the 4 motor operated valves SIS-MOV-014 A, B, C, D	2	No	Yes
Accumulator piping and valves on the RCS side of and including the check valves SIS-VLV-102 A, B, C, D	1	Yes	Yes
Accumulator piping and valves on the accumulator side of but excluding the check valves SIS-VLV-102 A, B, C, D	2	No	Yes
Emergency letdown isolation valves SIS-MOV-031A, 031D, 032A, 032D and piping between valves	1	No	Yes
Accumulator nitrogen vent piping up and including valves SIS-AOV-114, SIS-MOV-121A,B	2	No	Yes
NaTB solution transfer piping	2	No	Yes
RWSP transfer piping	2	No	Yes
Refueling cavity drain piping	2	No	Yes

Table 2.4.4-4 Emergency Core Cooling System Equipment, Alarms, Displays and Control Functions (Sheet 1 of 2)

Equipment/Instrument Name	MCR/RSC Alarm	MCR Display	MCR/RSC Control Function	RSC Display
Safety Injection Pumps (SIS-MPP-001A,B,C,D)	No	Yes	Yes	Yes
Safety Injection Pump Suction Isolation Valves (SIS-MOV-001A,B,C,D)	No	Yes	Yes	Yes
Safety Injection Pump Discharge Containment Isolation Valves (SIS-MOV-009A,B,C,D)	No	Yes	Yes	Yes
Direct Vessel Safety Injection Line Isolation Valves (SIS-MOV-011A,B,C,D)	No	Yes	Yes	Yes
Hot Leg Injection Isolation Valves (SIS-MOV-014A,B,C,D)	No	Yes	Yes	Yes
Emergency Letdown Line 1st, 2nd Isolation Valves (SIS-MOV-031A,D and 032A,D)	No	Yes	Yes	Yes
Accumulator Discharge Valves (SIS-MOV-101A,B,C,D)	Yes	Yes	Yes	Yes
Accumulator Nitrogen Supply Line Isolation Valves (SIS-MOV-125A,B,C,D)	No	Yes	Yes	Yes
Accumulator Nitrogen Discharge Valves (SIS-MOV-121A,B)	No	Yes	Yes	Yes
Safety Injection Pump Discharge Flow (SIS-FT-062,063,064,065)	No	Yes	No	Yes
Safety Injection Pump Minimum Flow (SIS-FT-072,073,074,075)	No	Yes	No	Yes
Safety Injection Pump Discharge pressure (SIS-PT-064,065,066,067)	No	Yes	No	Yes
Safety Injection Pump Suction pressure (SIS-PT-060,061,062,063)	No	Yes	No	Yes

Table 2.4.4-4 Emergency Core Cooling System Equipment, Alarms, Displays and Control Functions (Sheet 2 of 2)

Equipment/Instrument Name	MCR/RSC Alarm	MCR Display	MCR/RSC Control Function	RSC Display
Accumulator Pressure (SIS-PT-010, 020,030,040)	Yes	Yes	No	Yes
Accumulator Water Level (SIS-LT-010,020,030,040)	Yes	Yes	No	Yes
Refueling Water Storage Pit Water Level (RWS-LT-010,011,012,013)	Yes(1)	Yes	No	Yes
Accumulator Nitrogen Supply Containment Isolation valve (SIS-AOV-114)	No	Yes	Yes	Yes

NOTE:
1. Alarm function is not required for "RWS-LT-010" and "RWS-LT-012".

Table 2.4.4-5 Emergency Core Cooling System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 1 of 10)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1.a The functional arrangement of the ECCS is as described in the Design Description of Subsection 2.4.4.1 and in Table 2.4.4-1 and as shown in Figure 2.4.4-1.	1.a Inspection of the as-built ECCS will be performed.	1.a The as-built ECCS conforms to the functional arrangement as described in the Design Description of Subsection 2.4.4.1 and in Table 2.4.4-1 and as shown in Figure 2.4.4-1.
1.b Each mechanical division of the ECCS (Divisions A, B, C & D) is physically separated from the other divisions, with the exception of inside the containment, so as not to preclude accomplishment of the safety function.	1.b Inspections and analysis of the as-built ECCS will be performed.	1.b A report exists and concludes that each mechanical division of the as-built ECCS is physically separated from other mechanical divisions of the system by spatial separation, barriers, or enclosures, with the exception of inside the containment, so as to assure that the functions of the safety-related system are maintained.
2.a.i The ASME Code Section III components of the ECCS, identified in Table 2.4.4-2 are fabricated, installed and inspected in accordance with ASME Code Section III requirements.	2.a.i Inspection of the as-built ASME Code Section III components of the ECCS, identified in Table 2.4.2-2, will be performed.	2.a.i The ASME Code Section III data report(s) (certified, when required by ASME Code) and inspection reports (including N-5 Data Reports where applicable) exist and conclude that the as-built ASME Code Section III components of the ECCS identified in Table 2.4.4-2 are fabricated, installed, and inspected in accordance with ASME Code Section III requirements.
2.a.ii The ASME Code Section III components of the ECCS identified in Table 2.4.4-2 are reconciled with the design requirements.	2.a.ii A reconciliation analysis of the components identified in Table 2.4.4-2 using as-designed and as-built information and ASME Code Section III design report(s) (NCA-3550) will be performed.	2.a.ii The ASME Code Section III design report(s) (certified, when required by ASME Code) exist and conclude that the design reconciliation has been completed in accordance with the ASME Code Section III for the as-built components of the ECCS identified in Table 2.4.4-2. The report documents the results of the reconciliation analysis.

Table 2.4.4-5 Emergency Core Cooling System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 2 of 10)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
2.b.i The ASME Code Section III piping of the ECCS, including supports, identified in Table 2.4.4-3, is fabricated, installed, and inspected in accordance with ASME Code Section III requirements.	2.b.i Inspection of the as-built ASME Code Section III piping of the ECCS, including supports, identified in Table 2.4.4-3, will be performed.	2.b.i The ASME Code Section III data report(s) (certified when required by ASME Code) and inspection reports (including N-5 Data Reports where applicable) exist and conclude that the as-built ASME Code Section III piping of the ECCS, including supports, identified in Table 2.4.4-3, is fabricated, installed, and inspected in accordance with ASME Code Section III requirements.
2.b.ii The ASME Code Section III piping of the ECCS, including supports, identified in Table 2.4.4-3, is reconciled with the design requirements.	2.b.ii A reconciliation analysis of the piping of the ECCS, including supports, identified in Table 2.4.4-3, using as-designed and as-built information and ASME Code Section III design report(s) (NCA-3550) will be performed.	2.b.ii The ASME Code Section III design report(s) (certified, when required by ASME Code) exist and conclude that the design reconciliation has been completed in accordance with the ASME Code, for the as-built ASME Code Section III piping of the ECCS, including supports, identified in Table 2.4.4-3. The report documents the results of the reconciliation analysis.
3.a Pressure boundary welds in ASME Code Section III components, identified in Table 2.4.4-2, meet ASME Code Section III requirements for non-destructive examination of welds.	3.a Inspections of the as-built pressure boundary welds in ASME Code Section III components identified in Table 2.4.4-2, will be performed in accordance with the ASME Code Section III.	3.a The ASME Code Section III code reports exist and conclude that the ASME Code Section III requirements are met for non-destructive examination of the as-built pressure boundary welds in ASME Code Section III components identified in Table 2.4.4-2.
3.b Pressure boundary welds in ASME Code Section III piping, identified in Table 2.4.4-3, meet ASME Code Section III requirements for non-destructive examination of welds.	3.b Inspections of the as-built pressure boundary welds in ASME Code Section III piping identified in Table 2.4.4-3, will be performed in accordance with the ASME Code Section III.	3.b The ASME Code Section III code reports exist and conclude that the ASME Code Section III requirements are met for non-destructive examination of as-built pressure boundary welds in ASME Code Section III piping identified in Table 2.4.4-3.

Table 2.4.4-5 Emergency Core Cooling System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 3 of 10)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4.a The ASME Code Section III components, identified in Table 2.4.4-2, retain their pressure boundary integrity at their design pressure.	4.a A hydrostatic test will be performed on the as-built components, identified in Table 2.4.4-2, required by the ASME Code Section III to be hydrostatically tested.	4.a ASME Code Data Report(s) exist and conclude that the results of the hydrostatic test of the as-built components identified in Table 2.4.4-2 as ASME Code Section III conform to the requirements of the ASME Code Section III.
4.b The ASME Code Section III piping, identified in Table 2.4.4-3, retains its pressure boundary integrity at its design pressure.	4.b A hydrostatic test will be performed on the as-built piping, identified in Table 2.4.4-3, required by the ASME Code Section III to be hydrostatically tested.	4.b ASME Code Data Report(s) exist and conclude that the results of the hydrostatic test of the as-built piping identified in Table 2.4.4-3 as ASME Code Section III conform to the requirements of the ASME Code Section III.
5.a The seismic Category I equipment, identified in Table 2.4.4-2, can withstand seismic design basis loads without loss of safety function.	5.a.i Inspections will be performed to verify that the as-built seismic Category I equipment identified in Table 2.4.4-2 is located in a seismic Category I structure.	5.a.i The as-built seismic Category I equipment identified in Table 2.4.4-2 is located in a seismic Category I structure.
	5.a.ii Type tests, analyses, or a combination of type tests and analyses of seismic Category I equipment identified in Table 2.4.4-2 will be performed using analytical assumptions, or will be performed under conditions, which bound the seismic design basis requirements.	5.a.ii A report exists and concludes that the seismic Category I equipment identified in Table 2.4.4-2 can withstand seismic design basis loads without loss of safety function.
	5.a.iii Inspections and analyses will be performed to verify that the as-built seismic Category I equipment identified in Table 2.4.4-2 including anchorages, is seismically bounded by the tested or analyzed conditions.	5.a.iii A report exists and concludes that the as-built seismic Category I equipment identified in Table 2.4.4-2, including anchorages, is seismically bounded by the tested or analyzed conditions.

Table 2.4.4-5 Emergency Core Cooling System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 4 of 10)

Design Commitment		Inspections, Tests, Analyses		Acceptance Criteria	
5.b	The seismic Category I piping, including supports, identified in Table 2.4.4-3 can withstand seismic design basis loads without a loss of its safety function.	5.b.i	Inspections will be performed to verify that the as-built seismic Category I piping, including supports, identified in Table 2.4.4-3 is supported by a seismic Category I structure(s).	5.b.i	The as-built seismic Category I piping, including supports, identified in Table 2.4.4-3 is supported by a seismic Category I structure(s).
		5.b.ii	Inspections and analyses will be performed to verify that the as-built seismic Category I piping, including supports, identified in Table 2.4.4-3 can withstand seismic design basis loads without a loss of its safety function.	5.b.ii	A report exists and concludes that the as-built seismic Category I piping, including supports, identified in Table 2.4.4-3 can withstand seismic design basis loads without a loss of its safety function.
6.a	The Class 1E equipment identified in Table 2.4.4-2 as being qualified for a harsh environment can withstand the environmental conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function.	6.a.i	Type tests or a combination of type tests and analyses using the design environmental conditions, or under the conditions which bound the design environmental conditions, will be performed on the Class 1E equipment identified in Table 2.4.4-2 as being qualified for a harsh environment.	6.a.i	A report exists and concludes that the Class 1E equipment identified in Table 2.4.4-2 as being qualified for a harsh environment can withstand the environmental conditions that would exist before, during, and following a design basis accident without loss of safety function for the time required to perform the safety function.
		6.a.ii	Inspection will be performed on the as-built Class 1E equipment identified in Table 2.4.4-2 as being qualified for a harsh environment and the associated wiring, cables, and terminations located in a harsh environment.	6.a.ii	The as-built Class 1E equipment and the associated wiring, cables, and terminations identified in Table 2.4.4-2 as being qualified for a harsh environment are bounded by type tests or a combination of type tests and analyses.

Table 2.4.4-5 Emergency Core Cooling System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 5 of 10)

Design Commitment		Inspections, Tests, Analyses		Acceptance Criteria	
6.b	Class 1E equipment, identified in Table 2.4.4-2, is powered from its respective Class 1E division.	6.b	A test will be performed on each division of the as-built Class 1E equipment identified in Table 2.4.4-2 by providing a simulated test signal only in the Class 1E division under test.	6.b	The simulated test signal exists at the as-built Class 1E equipment identified in Table 2.4.4-2 under test.
6.c	Separation is provided between redundant divisions of ECCS Class 1E cables, and between Class 1E cables and non-Class 1E cables.	6.c	Inspections of the as-built Class 1E divisional cables will be performed.	6.c	Physical separation or electrical isolation is provided in accordance with RG 1.75, between the as-built cables of redundant ECCS Class 1E divisions and between Class 1E cables and non-Class 1E cables.
7.a	Deleted.	7.a	Deleted.	7.a	Deleted.
7.b	The ECCS provides RCS makeup, boration, and safety injection during design basis events.	7.b.i.a	An injection test with low tank pressure condition for each as-built accumulator will be conducted. The test will be initiated by opening isolation valve(s) in the piping being tested. Each as-built accumulator will be partially filled with water and pressurized with nitrogen. All valves in these lines will be open during the test. An analysis will be performed to determine the water volume injected.	7.b.i.a	A report exists and concludes that the total water volume injected from each as-built accumulator into the reactor vessel is $\geq$2126 ft^3. The water volume injected from each accumulator into reactor vessel at large flow rate (prior to flow switching to small flow rate) is $\geq$1326.8 ft^3.
		7.b.i.b	Tests and analyses of the as-built accumulator system will be performed to calculate the resistance coefficients of the as-built accumulator system.	7.b.i.b	A report exists and concludes that the calculated resistance coefficients of the as-built accumulator system (based on a cross-section area of 0.6827 ft^2) meet the requirements shown in Table 2.4.4-6.

Table 2.4.4-5 Emergency Core Cooling System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 6 of 10)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	7.b.ii The as-built safety injection pump injection test will be performed. Analysis will be performed to convert the test results from the test conditions to the design condition.	7.b.ii A report exists and concludes that each as-built safety injection pump has a pump differential head of no less than 3937 ft and no more 4527 ft at the minimum flow, and injects no less than 1259 gpm and no more than 1462 gpm of RWSP water into the reactor vessel at atmospheric pressure.
	7.b.iii.a Inspections of each as-built accumulator will be conducted.	7.b.iii a The volume of each as-built accumulator is at least 3,180 ft^3
	7.b.iii.b Inspections of the RWSP will be conducted	7.b.iii.b The volume of the as-built RWSP is at least 81,230 ft^3
	7.b.iv Inspection and analysis of the as-built ECC/CS suction strainers will be conducted. Replace with "is greater than or equal to 2,730 ft2;"	7.b.iv A report exists and concludes that each of the four as-built ECC/CS suction strainers have the following features: stainless steel materials of construction for corrosion resistance; a minimum strainer surface area ~~of 3510 square feet~~; perforated plate with maximum hole diameter of 0.066 inches; remains submerged under design basis accident conditions ; achieves head loss consistent with design basis NPSH evaluations
	7.b.v Inspections and analyses of the as-built coatings used in the containment will be conducted.	7.b.v A report exists and concludes that the as-built coatings used in the containment are consistent with the ECC/CS suction strainer debris generation, debris transport and downstream effects evaluations.

Table 2.4.4-5 Emergency Core Cooling System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 7 of 10)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	7.b.vi Inspections of the as-built insulation used in the containment will be conducted	7.b.vi A report exists and concludes that the as-built insulation in containment is consistent with design basis evaluations of suction strainer performance and downstream effects.
7.c The ECCS provides pH adjustment of water flooding the containment following design basis accidents.	7.c Inspections and analyses of the as-built NaTB baskets will be conducted.	7.c A report exists and concludes that the as-built NaTB baskets contain a total calculated weight of NaTB of ≥44,100 pounds. The tops of the as-built NaTB baskets are located below plant elevation 131 ft, 6 in.
7.d The safety injection pumps have sufficient net positive suction head (NPSH).	7.d Tests to measure the as-built safety injection pump suction pressure will be performed. Inspections and analysis to determine NPSH available to each safety injection pump will be performed. The analysis will consider vendor test results of required NPSH and the effects of: - pressure losses for pump inlet piping and components, - pressure losses for pump suction strainers due to debris blockage, - suction from the RWSP water level at the minimum value.	7.d A report exists and concludes that the as-built NPSH available to each safety injection pump is greater than the NPSH required.
8. Controls are provided in the MCR to open and close the remotely operated valves identified in Table 2.4.4-2.	8. Tests will be performed on the as-built remotely operated valves identified in Table 2.4.4-2 using controls in the as-built MCR.	8. Controls in the as-built MCR open and close the as-built remotely operated valves identified in Table 2.4.4-2.

Table 2.4.4-5 Emergency Core Cooling System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 8 of 10)

Design Commitment		Inspections, Tests, Analyses		Acceptance Criteria	
9.a	The motor-operated, air-operated and check valves, identified in Table 2.4.4-2 as having an active safety function, perform an active safety function to change position as indicated in the table.	9.a.i	Type tests or a combination of type tests and analyses of motor-operated and air-operated valves identified in Table 2.4.4-2 as having an active safety function will be performed that demonstrate the capability of the valve to operate under its design conditions.	9.a.i	A report exists and concludes that each motor-operated and air-operated valve identified in Table 2.4.4-2 as having an active safety function changes position as indicated in Table 2.4.4-2 under design conditions.
		9.a.ii	Tests of the as-built motor-operated and air-operated valves identified in Table 2.4.4-2 as having an active safety function will be performed under preoperational flow, differential pressure, and temperature conditions.	9.a.ii	Each as-built motor-operated and air-operated valve identified in Table 2.4.4-2 as having an active safety function changes position as indicated in Table 2.4.4-2 under preoperational test conditions.
		9.a.iii	Inspections will be performed of the as-built motor-operated and air-operated valves identified in Table 2.4.4-2 as having an active safety function.	9.a.iii	Each as-built motor-operated and air-operated valve identified in Table 2.4.4-2 as having an active safety function is bounded by the type tests, or a combination of type tests and analyses.
		9.a.iv	Tests of the as-built check valves identified in Table 2.4.4-2 as having an active safety function will be performed under preoperational test pressure, temperature, and fluid flow conditions.	9.a.iv	Each as-built check valve identified in Table 2.4.4-2 as having an active safety function changes position as indicated in Table 2.4.4-2 under preoperational test conditions.
9.b	After loss of motive power, the remotely operated valves, identified in Table 2.4.4-2, assume the indicated loss of motive power position.	9.b.	Tests of the as-built remotely operated valves identified in Table 2.4.4-2 will be performed under the conditions of loss of motive power.	9.b	Upon loss of motive power, each as-built remotely operated valve identified in Table 2.4.4-2 assumes the indicated loss of motive power position.

Table 2.4.4-5 Emergency Core Cooling System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 9 of 10)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
10.a Controls are provided in the MCR to start and stop the safety injection pumps identified in Table 2.4.4-4.	10.a Tests will be performed on the as-built safety injection pumps identified in Table 2.4.4-4 using controls in the as-built MCR.	10.a Controls in the as-built MCR start and stop the as-built safety injection pumps identified in Table 2.4.4-4.
10.b The pumps identified in Table 2.4.4-4 start after receiving an ECCS actuation signal.	10.b Tests will be performed on the as-built pumps identified in Table 2.4.4-4 using simulated signals.	10.b The as-built pumps identified in Table 2.4.4-4 start after receiving a simulated ECCS actuation signal.
10.c A confirmatory-open interlock is provided to automatically open the accumulator discharge valve upon the receipt of an ECCS actuation signal or an above low pressurizer pressure (P11) setpoint signal.	10.c Tests will be performed using simulated signals.	10.c The as-built accumulator discharge valves identified in Table 2.4.4-2 automatically opens upon either the receipt of simulated ECCS actuation or above low pressurizer pressure signal.
11. Alarms and displays identified in Table 2.4.4-4 are provided in the MCR.	11. Inspection will be performed for retrievability of the alarms and displays identified in Table 2.4.4-4 in the as-built MCR.	11. Alarms and displays identified in Table 2.4.4-4 can be retrieved in the as-built MCR.
12. Alarms, displays and controls identified in Table 2.4.4-4 are provided in the RSC.	12.i Inspection will be performed for retrievability of the alarms and displays identified in Table 2.4.4-4 in the as-built RSC.	12.i Alarmsand displays identified in Table 2.4.4-4 can be retrieved in the as-built RSC.
	12.ii Tests of the as-built RSC control functions identified in Table 2.4.4-4 will be performed.	12.ii Controls in the as-built RSC operate the as-built equipment identified in Table 2.4.4-4 with an RSC control function.
13. The piping identified in Table 2.4.4-3 as designed for LBB meets the LBB criteria, or an evaluation is performed of the protection from the dynamic effects of a rupture of the line.	13. Inspections of the as-built piping identified in Table 2.4.4-3 will be performed based on the evaluation report for LBB or for the evaluation of the protection from dynamic effects of a pipe break, as specified in Section 2.3.	13. An LBB evaluation report exists and concludes that the LBB acceptance criteria are met by the as-built piping identified in Table 2.4.4-3 and piping materials, or a pipe break hazards analysis report exists and concludes that protection is provided from the dynamic effects of a line break is provided.

Table 2.4.4-5 Emergency Core Cooling System Inspections, Tests, Analyses, and Acceptance Criteria (Sheet 10 of 10)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
14.a Deleted	14.a Deleted.	14.a Deleted.
14.b Deleted.	14.b Deleted.	14.b Deleted.

Table 2.4.4-6 Requirement for Accumulator System Resistance Coefficient

Operation mode	Resistance coefficient (based on a cross-section area of 0.6827 ft^2)
Large flow injection	$\geq \frac{1}{[x\{0.7787-0.6889\exp(-0.5238\sigma_V)\}]^2}+461.7f+1.99$ $\leq \frac{1}{[y\{0.7787-0.6889\exp(-0.5238\sigma_V)\}]^2}+564.3f+2.21$ Where σ_V :cavitation factor $x = 1+\frac{\text{uncertainty}(\%)}{100}$ $y = 1-\frac{\text{uncertainty}(\%)}{100}$ f : friction factor of piping
Small flow injection	$\geq \frac{1}{[x\{0.07197-0.01904\exp(-6.818\sigma_V)\}]^2}+461.7f+1.99$ $\leq \frac{1}{[y\{0.07197-0.01904\exp(-6.818\sigma_V)\}]^2}+564.3f+2.21$ Where σ_V :cavitation factor $x = 1+\frac{\text{uncertainty}(\%)}{100}$ $y = 1-\frac{\text{uncertainty}(\%)}{100}$ f : friction factor of piping

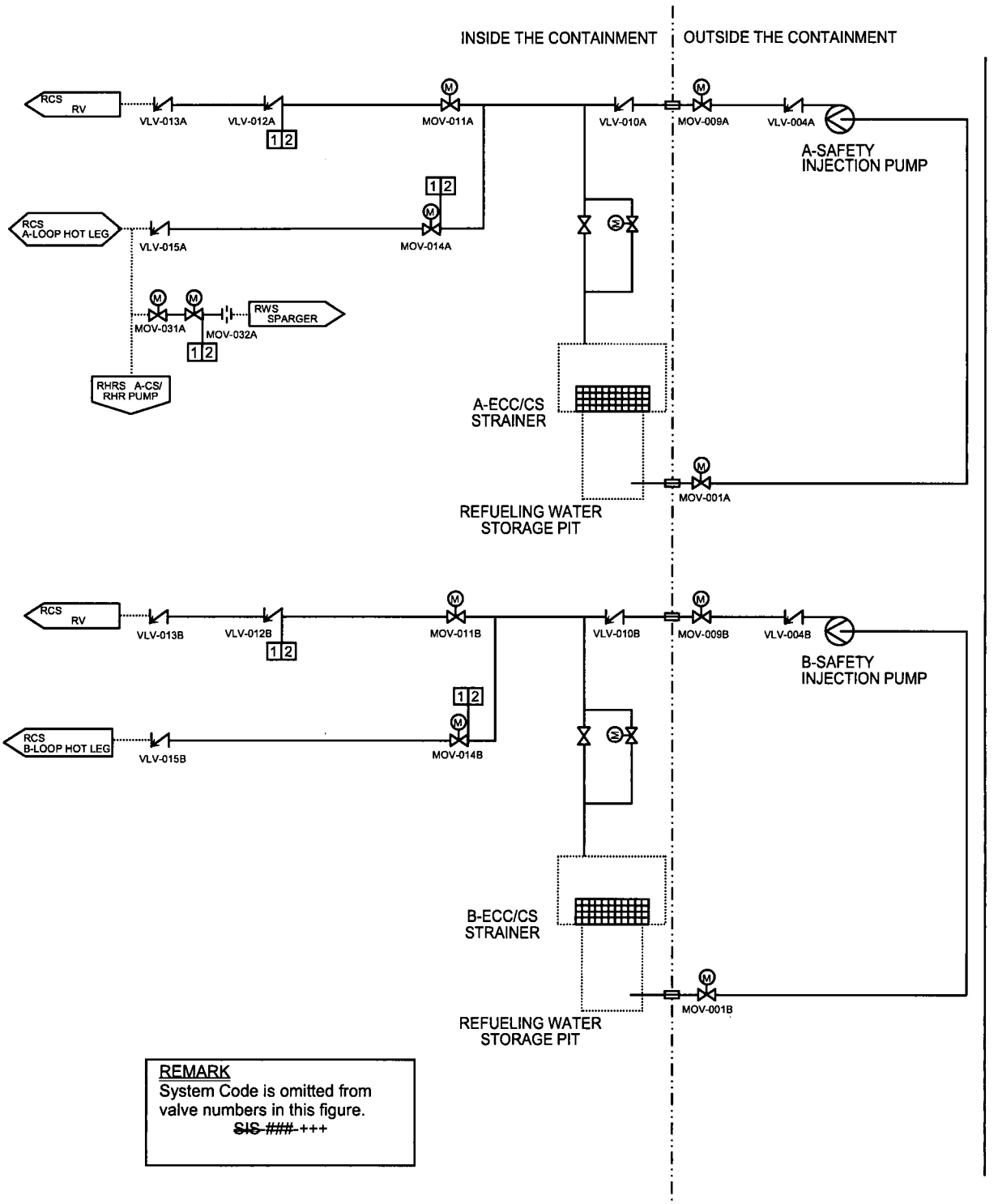

Figure 2.4.4-1 Emergency Core Cooling System (Sheet 1 of 4)

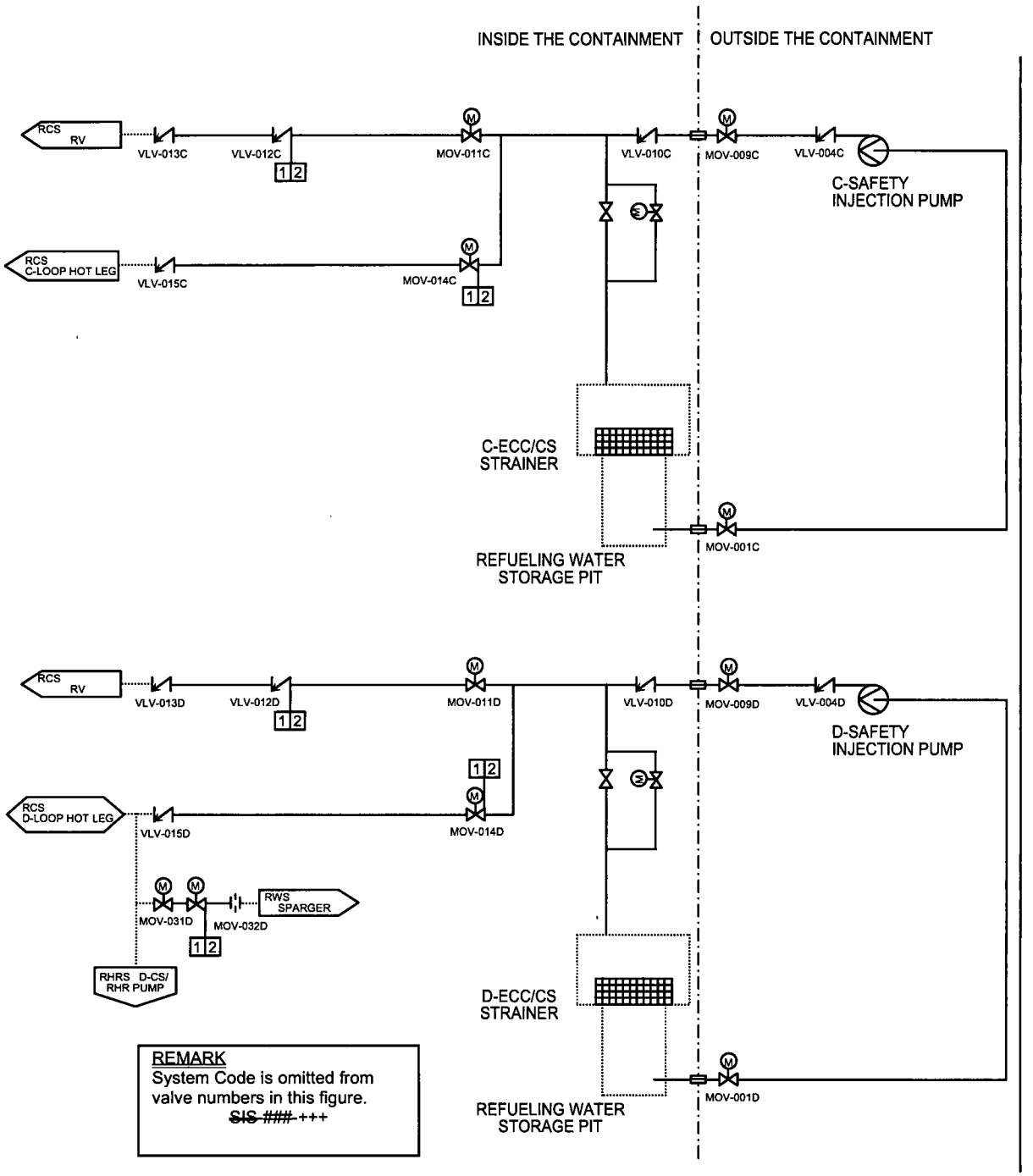

Figure 2.4.4-1 Emergency Core Cooling System (Sheet 2 of 4)

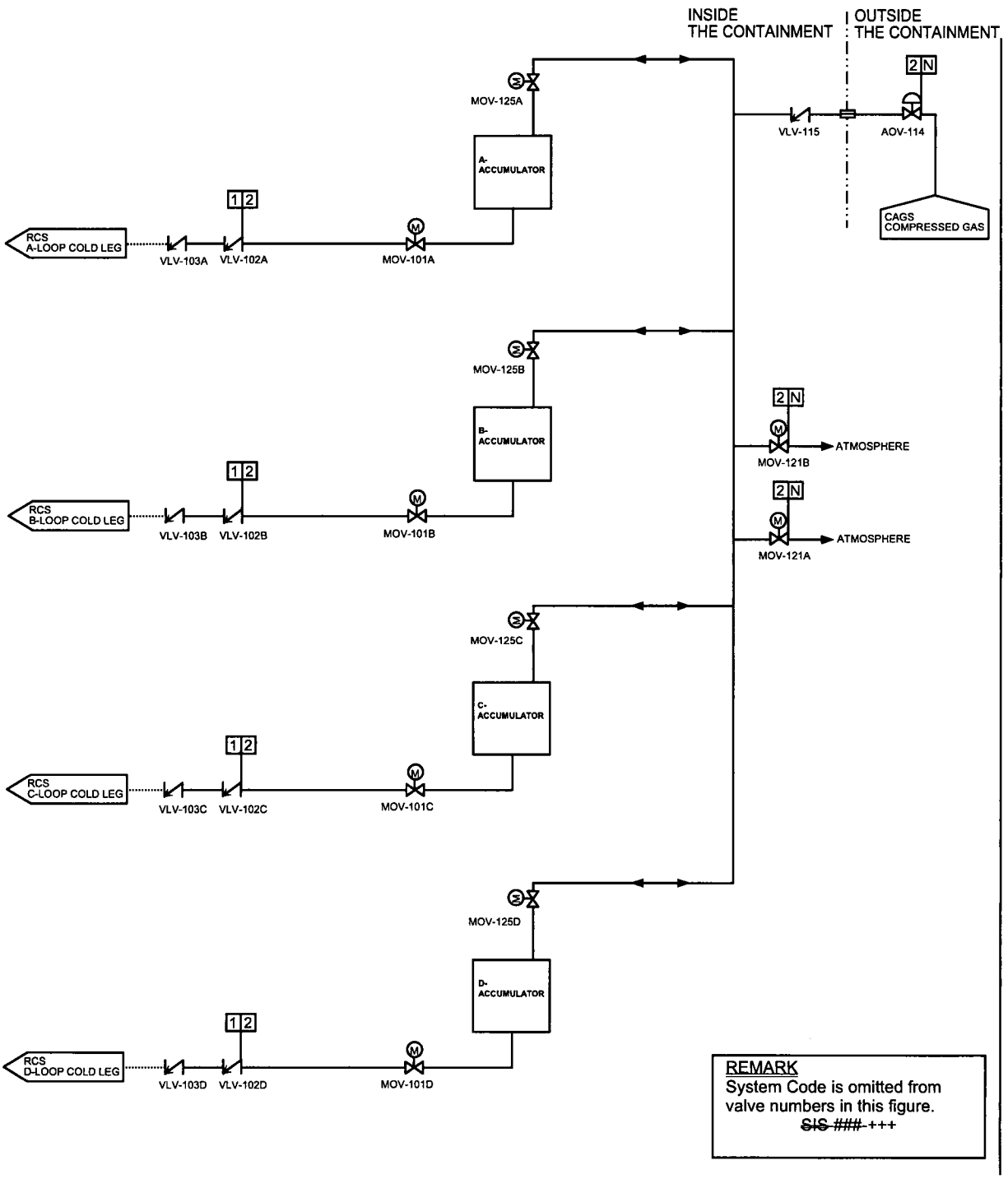

Figure 2.4.4-1 Emergency Core Cooling System (Sheet 3 of 4)

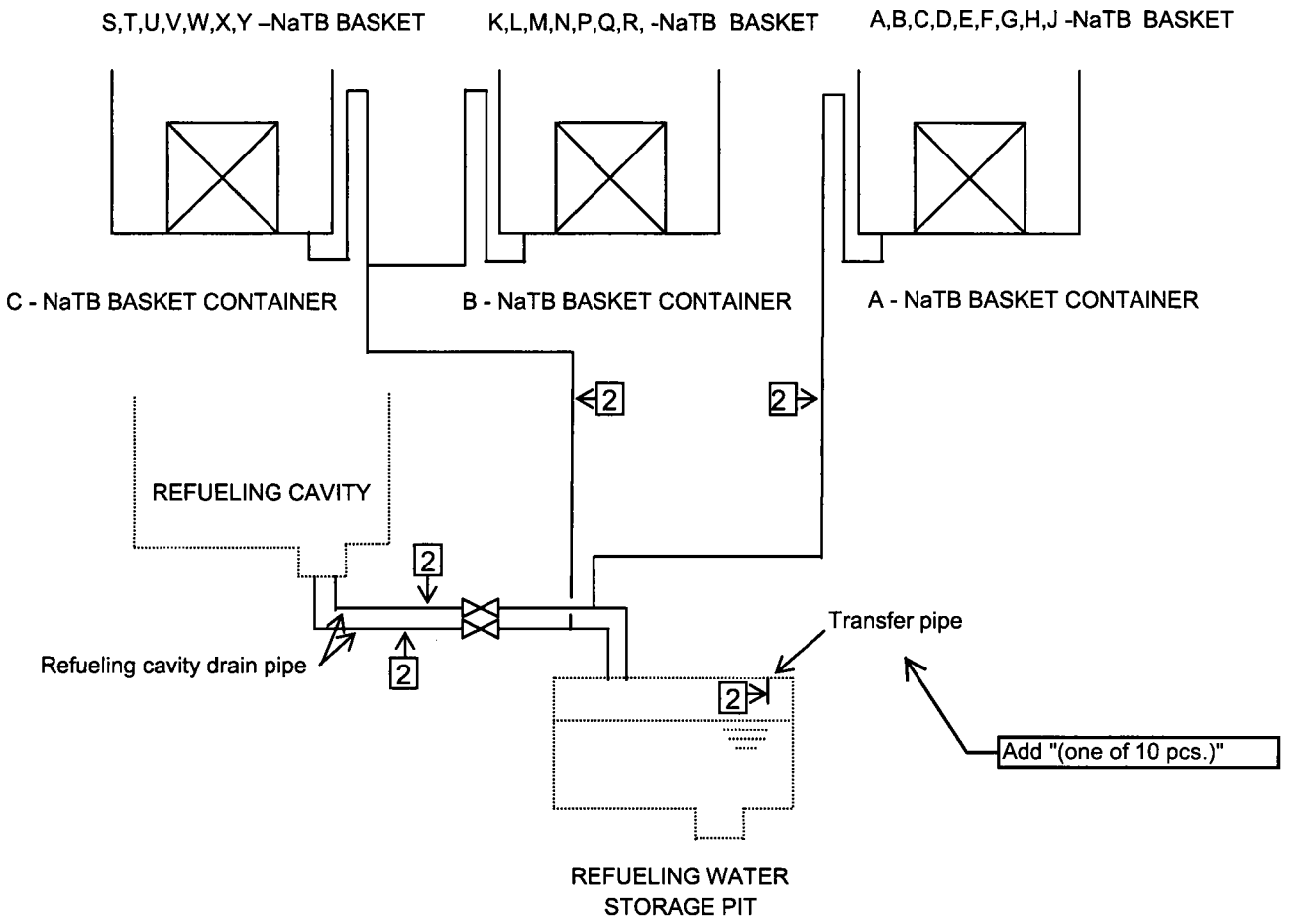

Figure 2.4.4-1 Emergency Core Cooling System (Sheet 4 of 4)

Tier-2

Chapter 1

1.6Material Interface

1.8Interfaces for Standard Design

1.9Conformance with Regulatory Criteria

Table 1.6-1 Material Referenced

Report Number(1)	Title	DCD Section Number
MUAP-07001-P MUAP-07001-NP	The Advanced Accumulator, Revision 3, March 2011	1.5.4, 6.3.7
MUAP-07006-P MUAP-07006-P	Defense-in-Depth and Diversity, Revision 2, June 2008	1.5.4, 7.1.5, 7.3.5, 7.8.5, 7.9.5
MUAP-07007-P MUAP-07007-NP	HSI System Description and HFE Process, Revision 3, October 2009	1.5.4, 7.1.5, 7.5.5, 7.6.5, 18.1.7, 18.2.5, 18.3.5, 18.4.5, 18.7.5, 18.8.5, 18.9.5, 18.10.5
MUAP-07008-P MUAP-07008-NP	Mitsubishi Fuel Design Criteria and Methodology, Revision 2, July 2010	4.2.6, 4.3.6, 4.4.8, 15.0.5, 15.4.11,
MUAP-07009-P MUAP-07009-NP	Thermal Design Methodology, May 2007	4.4.8, 15.0.5, 15.1.7, 15.2.10, 15.3.6, 15.4.11, 15.6.7
MUAP-07010-P MUAP-07010-NP	Non-LOCA Methodology, Revision 1, October 2010	6.2.9, 15.0.5, 15.1.7, 15.2.10, 15.3.6, 15.4.11, 15.5.4, 15.6.7
MUAP-07011-P MUAP-07011-NP	Large Break LOCA Code Applicability Report for US-APWR, Revision 1, March 2011	1.5.4, 6.3.7, 15.0.5, 15.6.7
MUAP-07012-P-A MUAP-07012-NP-A	LOCA Mass and Energy Release Analysis Code Applicability Report for US-APWR, Revision 2, June 2009	6.2.9
MUAP-07013-P MUAP-07013-NP	Small Break LOCA Methodology for US-APWR, Revision 2, October 2010	6.2.9, 15.0.5, 15.6.7
MUAP-07034-P MUAP-07034-NP	FINDS: Mitsubishi PWR Fuel Assemblies Seismic Analysis Code	4.2
PQD-DH-19005	Quality Assurance Program (QAP) Description For Design Certification of the US-APWR, Revision 3, September 2009	17.5.5, 18.1.7, 18.10.5

NOTE: -P(**p**roprietary) , -NP(**n**on-**p**roprietary)

Add following TeRs associated with GSI-191:
MUAP-08001-P Sump Strainer Performance
MUAP-08001-NP
MUAP-08011-P Chemical Effects Test Result
MUAP-08011-NP
MUAP-08012-NP Strainer Stress Report
MUAP-08013-P Downstream Effects
MUAP-08013-NP

5.2.3, 6.2.2, 6.2.9, 6.3.2

Table 1.8-2 Compilation of All Combined License Applicant Items for Chapters 1-19 (Sheet 14 of 34)

COL ITEM NO.	COL ITEM
COL 5.4(4)	*Deleted*
COL 5.4(5)	*Deleted*
COL 5.4(6)	*Deleted*
COL 5.4(7)	*Deleted*
COL 6.1(1)	*Deleted*
COL 6.1(2)	*Deleted*
COL 6.1(3)	*Deleted*
COL 6.1(4)	*Deleted*
COL 6.1(5)	*Deleted*
COL 6.1(6)	*Deleted*
COL 6.1(7)	*The COL Applicant is responsible for identifying the implementation milestones for the coatings program.*
COL 6.2(1)	*Deleted*
COL 6.2(2)	*Deleted*
COL 6.2(3)	*Deleted*
COL 6.2(4)	*Deleted*
COL 6.2(5)	*Preparation of a cleanliness, housekeeping and foreign materials exclusion program is the responsibility of the COL Applicant. This program ~~addresses other debris sources such as latent debris inside containment. This program minimizes foreign materials in the containment~~.*
COL 6.2(6)	*Deleted*
COL 6.2(7)	*Deleted*
COL 6.2(8)	*The COL Applicant is responsible for identifying the implementation milestone for the containment leakage rate testing program described under 10 CFR 50, Appendix J.*
COL 6.2(9)	*Deleted*
COL 6.2(10)	*Deleted*
COL 6.3(1)	*Deleted*
COL 6.3(2)	*Deleted*
COL 6.3(3)	*Deleted*
COL 6.3(4)	*Deleted*
COL 6.3(5)	*Deleted*
COL 6.3(6)	*Deleted*

will be established to limit 200lbs of latent debris, and to limit the allocated 200ft2 of miscellaneous debris per sump.

Insert below statement for COL 6.2(6):
"Preparation of administrative procedures is the responsibility of the COL Applicant. The procedures will ensure that RMI and fiber insulation debris within ZOIs will be consistent with the design basis debris specified in Table 6.2.2-4, and will ensure that the aluminum in containment exposed to containment spray water is limited to equal ot less than 810 ft2."

Table 1.9.1-1 US-APWR Conformance with Division 1 Regulatory Guides (Sheet 1 of 20)

Reg Guide Number	Title	Status	Corresponding Chapter/Section/ Subsection
1.1	Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal System Pumps (Rev. 0, November 1970)	Not applicable. SIP and CS/RHRP are designed so that adequate NPSH are provided to system pumps in accordance with Regulatory Guide 1.82 Rev.3.	N/A
1.4	Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors (Rev. 2, June 1974)	Not applicable. The guidance of Regulatory Guide 1.183, "Alternative Radiological Source Terms For Evaluating Design Basis Accidents at Nuclear Power Reactors" is applied instead of Regulatory Guide 1.4.	N/A
1.6	Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems (Rev. 0, March 1971)	Conformance with no exceptions identified.	8.1.5.3
1.7	Control of Combustible Gas Concentrations in Containment (Rev. 3, March 2007)	Conformance with no exceptions identified.	6.2.5.1, 19.2
1.8	Qualification and Training of Personnel for Nuclear Power Plants (Revision 3, May 2000)	Not applicable. RG applies to a site-specific operational program.	12.1.1.3.1, 12.1.4
1.9	Selection, Design, Qualification, and Testing of Emergency Diesel Generator Units Used as Class 1E Onsite Electric Power Systems at Nuclear Power Plants (Rev. 4, March 2007)	Conformance with no exceptions identified. US-APWR has no diesel generators, but will use gas turbine generators for emergency power in the standard design.	8.1.5.3, 14.2.12 (Note: MHI has generated a position on the use of gas turbine generators for emergency power that meets the intent of RG)
1.11	Instrument Lines Penetrating Primary Reactor Containment (Rev. 0, March 1971)	Conformance with exceptions. Isolation valve is not adopted to instrument lines for containment pressure.	6.2.4.1

Table 1.9.1-1 US-APWR Conformance with Division 1 Regulatory Guides (Sheet 8 of 20)

Reg Guide Number	Title	Status	Corresponding Chapter/Section/ Subsection
1.78	Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release (Rev. 1, December 2001)	Conformance with exceptions. Full conformance by COL Applicant with site-specific consequence data.	6.4.4, 9.4.1
1.79	Preoperational Testing of Emergency Core Cooling Systems for Pressurized Water Reactors (Rev. 1, September 1975)	Conformance with no exceptions identified.	14.2.7
1.81	Shared Emergency and Shutdown Electric Systems for Multi-Unit Nuclear Power Plants (Rev. 1, January 1975)	Not applicable. DCD describes a single reference plant design; RG applies to a site-specific multi-unit situation.	N/A
1.82	Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident (Rev. 3, November 2003)	Conformance with exceptions. Full conformance by COL Applicant with site-specific conditions.	~~6.2.2.1~~
1.83	Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes (Rev. 1, July 1975)	Withdrawn..	N/A
1.84	Design, Fabrication, and Materials Code Case Acceptability, ASME Section III (Rev. 33, August 2005)	Conformance with no exceptions identified.	3.12.2.2
1.86	Termination of Operating Licenses for Nuclear Reactors (Rev. 0, June 1974)	Not applicable. RG applies to a later phase site-specific operational program.	N/A
1.87	Guidance for Construction of Class 1 Components in Elevated-Temperature Reactors (Supplement to ASME Section III Code Cases 1592, 1593, 1594, 1595, and 1596) (Rev. 0, June 1975)	Not applicable.	N/A
1.89	Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants (Rev. 1, June 1984)	Conformance with no exceptions identified.	3.11, 7.1.3, 8.1.5.3
1.90	Inservice Inspection of Prestressed Concrete Containment Structures with Grouted Tendons (Rev. 1, August 1977)	Not applicable. US-APWR is not among the designs covered by this RG. US-APWR PCCV tendon type is Ungrouted.	N/A

Replace with "6.2.2.2.6, 6.2.2.3"

Table 1.9.2-5 US-APWR Conformance with Standard Review Plan Chapter 5 Reactor Coolant and Connecting Systems (Sheet 9 of 16)

SRP Section and Title	SRP Excerpt Indicating Acceptance Criteria for DCD	Status	Appears in DCD Chapter/Section
5.4.7 Residual Heat Removal (RHR) System	1. The system or systems must satisfy the functional, isolation, pressure relief, pump protection, and test requirements specified in Branch Technical Position BTP 5-4. 2. To meet the requirements of GDC 4, design features and operating procedures should be provided to prevent damaging water hammer caused by such mechanisms as voided lines. 3. Interfaces between the RHR system and the RCIC and component or service water systems should be designed so that operation of one does not interfere with, and provides proper support (where required) for, the other. In relation to these and other shared systems (e.g., emergency core cooling and containment heat removal systems), the RHR system must conform to GDC 5. 4. When the RHR system is used to control or mitigate the consequences of an accident, it must meet the design requirements of an engineered safety feature system. This includes meeting the guidelines of Regulatory Guide 1.82 regarding water sources for long term recirculation cooling following a loss-of-coolant accident.	Conformance with no exceptions identified.	5.4.7
5.4.8 Reactor Water Cleanup System (BWR)	This SRP is for boiling water reactors and does not apply to the US-APWR ...	Not applicable. Applies to BWRs only.	N/A
5.4.11 Pressurizer Relief Tank	1. Acceptance as it relates to the protection of essential systems from the effects of earthquakes is based on meeting the guidelines in Position C.2 of Regulatory Guide 1.29 regarding the location of the tank in relation to other plant systems (the design of the tank system should be such that the plant safety-related systems would continue to perform their safety functions in the event of a tank failure) and in Position C.3 regarding the extension of seismic Category I boundaries.	Conformance with no exceptions identified. System design meets R.G. 1.29 and GDC 4 described in SRP Acceptance criteria.	5.4.11

Table 1.9.2-6 US-APWR Conformance with Standard Review Plan Chapter 6 Engineered Safety Features (Sheet 7 of 35)

SRP Section and Title	SRP Excerpt Indicating Acceptance Criteria for DCD	Status	Appears in DCD Chapter/Section
6.2.1.5 Minimum Containment Pressure Analysis for Emergency Core Cooling System Performance Capability Studies	1. To meet the requirements of 10 CFR 50.46(a)(1)(i), the model to determine minimum containment pressure for ECCS studies should comply with Regulatory Guide (RG) 1.157, Position C.3.12.1, which describes acceptable containment pressure models for ECCS performance analysis. 2. To meet the requirements of 10 CFR Part 50.46(a)(1)(ii), the following specific criteria indicate the conservatism that analyses of the containment response to LOCAs should have for determining the minimum containment pressure for ECCS performance capability studies: A. Calculations of the mass and energy released during postulated LOCAs should be based on the requirements of 10 CFR Part 50, Appendix K. B. Branch Technical Position 6-2, "Minimum Containment Pressure Model for PWR ECCS Performance Evaluation," delineates the calculation approach that should be followed for a conservative prediction of the minimum containment pressure.	Conformance with no exceptions identified.	6.2.1.5
6.2.2 Containment Heat Removal Systems	1. The containment heat removal systems should meet the redundancy and power source requirements for an engineered safety feature (i.e., the results of failure modes and effects analyses of each system should ensure that the system is capable of withstanding a single failure without loss of function). This conforms to the requirements of GDC 38.	Conformance with exceptions. Criteria 4 is not applied to US-APWR, because the US-APWR does not have the fan cooler system for containment heat removal following the design base accident.	6.2.2

Table 1.9.2-6 US-APWR Conformance with Standard Review Plan Chapter 6 Engineered Safety Features (Sheet 8 of 35)

SRP Section and Title	SRP Excerpt Indicating Acceptance Criteria for DCD	Status	Appears in DCD Chapter/Section
6.2.2 Containment Heat Removal Systems (continued)	2. With regard to GDC 38 as it relates to the capability of the containment system to accomplish its safety function, the spray system should be designed to accomplish this without pump damage caused by cavitation. A supporting analysis should be presented in sufficient detail to permit the staff to determine the adequacy of the analysis. This analysis should also demonstrate that the available NPSH is greater than or equal to the required NPSH. Regulatory Guide 1.82, Revision 3 (Ref. 1), describes methods acceptable to the staff for evaluating the NPSH margin. If containment accident pressure is credited in determining available NPSH, an evaluation of the contribution to plant risk from inadequate containment pressure should be made. One acceptable way of making this evaluation is to address the five key principles of risk-informed decision making stated in Section 2 of Regulatory Guide 1.174 (Ref. 2). 3. In evaluating the performance capability of the CSS to satisfy GDC 38, the analyses of its heat removal capability should be based on the following considerations: A. The locations of the spray headers relative to the internal structures. B. The arrangement of the spray nozzles on the spray headers and the expected spray pattern. The spray systems should be designed to ensure that the spray header and nozzle arrangements produce spray patterns which maximize the containment volume covered and minimize the overlapping of the sprays. C. The spray drop size spectrum and mean drop size emitted from each type of nozzle as a function of differential pressure across the nozzle. D. The effect of drop residence time and drop size on the heat removal effectiveness of the spray droplets.		

Table 1.9.2-6 US-APWR Conformance with Standard Review Plan Chapter 6 Engineered Safety Features (Sheet 9 of 35)

SRP Section and Title	SRP Excerpt Indicating Acceptance Criteria for DCD	Status	Appears in DCD Chapter/Section
6.2.2 Containment Heat Removal Systems (continued)	4. In evaluating the performance capability of the fan cooler system to satisfy GDC 38, the design heat removal capability (i.e., heat removal rate versus containment temperature) of the fan coolers should be established on the basis of qualification tests on production units or acceptable analyses that take into account the expected post accident environmental conditions and variations in major operating parameters, such as the containment atmosphere steam-air ratio, condensation on finned surfaces, and cooling water temperature and flow rate. The equipment housing and ducting associated with the fan cooler system should be analyzed to determine that the design is adequate to withstand the effects of containment pressure following a LOCA. Fan cooler system designs that contain components that do not have a post accident safety function should be designed so that failure of nonsafety-related equipment will not prevent the fan cooler system from accomplishing its safety function. 5. In evaluating the heat removal capability of the containment heat removal system to satisfy GDC 38, the potential for surface fouling of the secondary sides of fan cooler, recirculation, and RHR heat exchangers by the cooling water over the life of the plant and the effect of surface fouling on the heat removal capacity of the heat exchangers. The application should discuss the results of the analysis. The results will be acceptable if they demonstrate that provisions such as closed cooling water systems are provided 6.2.2-5 Revision 5 - March 2007 to prevent surface fouling or that surface fouling has been taken into account in the establishment of the heat removal capability of the heat exchangers.		

Table 1.9.2-6 US-APWR Conformance with Standard Review Plan Chapter 6 Engineered Safety Features (Sheet 10 of 35)

SRP Section and Title	SRP Excerpt Indicating Acceptance Criteria for DCD	Status	Appears in DCD Chapter/Section
6.2.2 Containment Heat Removal Systems (continued)	6. To satisfy the requirements of GDC 38 and 10 CFR 50.46(b)(5) regarding the long-term spray system(s) and ECCS(s), the containment emergency sump(s) in PWRs and suppression pools in BWRs should be designed to provide a reliable, long-term water source for ECCS and CSS pumps. The containment design should allow for the drainage of spray and emergency core cooling water to the emergency sump(s) or suppression pool and for recirculation of this water through the containment sprays and ECCSs. The design of the sumps or suppression pools and the protective strainer assemblies is a critical element in ensuring long-term recirculation cooling capability. Therefore, adequate design consideration of (1) sump and suppression pool hydraulic performance, (2) evaluation of potential debris generation and associated effects including debris screen blockage, (3) RHR and CSS pump performance under postulated post-LOCA conditions, and (4) impacts of debris penetrating strainers on long-term coolability of the core is necessary. Regulatory Guide 1.82, Revision 3, as modified and supplemented for PWRs by the Nuclear Energy Institute (NEI) Guidance Report (GR) (Ref. 3) and the NRC safety evaluation (SE) (Ref. 4), provide guidance for PWR debris evaluations. Regulatory Guide 1.82, Revision 3, as supplemented by the NRC-approved Boiling Water Reactor Owners' Group (BWROG) Utility Resolution Guidance (URG) (Ref. 5), provide guidance for BWR debris evaluations. 7. In meeting the requirements of GDC 39 and 40 regarding inspection and testing, the design of the containment heat removal systems should provide for periodic inspection and operability testing of the systems and system components such as pumps, valves, duct pressure-relieving devices, and spray nozzles.		

Table 1.9.2-6 US-APWR Conformance with Standard Review Plan Chapter 6 Engineered Safety Features (Sheet 11 of 35)

SRP Section and Title	SRP Excerpt Indicating Acceptance Criteria for DCD	Status	Appears in DCD Chapter/Section
6.2.2 Containment Heat Removal Systems (continued)	8. To satisfy the system design requirements of GDC 38, instrumentation should be provided to monitor the performance of the containment heat removal system and its components under normal and accident conditions. The instrumentation should determine whether a system is performing its intended function or whether a system train or component is malfunctioning and should be isolated.		
6.2.3 Secondary Containment Functional Design	This SRP is for boiling water reactor designs that feature secondary containments and does not apply to the US-APWR.	Not applicable. This is a BWR requirement; US-APWR does not have a secondary containment.	N/A
6.2.4 Containment Isolation System	1. Regulatory Guide (RG) 1.11 describes acceptable containment isolation provisions for instrument lines. In addition, instrument lines closed both inside and outside containment are designed to withstand pressure and temperature conditions following a loss-of-coolant accident (LOCA) and dynamic effects are acceptable without isolation valves. 2. Containment isolation provisions for lines in engineered safety feature or engineered safety feature-related systems may include remote-manual valves, but should detect possible leakage from these lines outside containment. 3. Containment isolation provisions for lines in systems needed for safe shutdown of the plant (e.g., liquid poison system, reactor core isolation cooling system, and isolation condenser system) may include remote-manual valves, but there should be provisions for detecting leakage from such lines outside containment.	Conformance with exceptions. Criterion 4 is not applied to US-APWR ,because there is no configuration that both isolation valves are outside containment.	6.2.4

Table 1.9.2-6 US-APWR Conformance with Standard Review Plan Chapter 6 Engineered Safety Features (Sheet 24 of 35)

SRP Section and Title	SRP Excerpt Indicating Acceptance Criteria for DCD	Status	Appears in DCD Chapter/Section
6.3 Emergency Core Cooling System (continued)	1. In regard to the ECCS acceptance criteria of 10 CFR 50.46, the five major performance criteria deal with: A. Peak cladding temperature. B. Maximum calculated cladding oxidation. C. Maximum hydrogen generation. D. Coolable core geometry E. Long-term cooling. Guidance, procedures and methods that are acceptable for meeting the requirements for a realistic or best-estimate evaluation model for ECCS performance can be found in Regulatory Guide 1.157. This method must identify and account for uncertainties in the analysis method and inputs such that there is a high level of probability that the acceptance criteria is not exceeded (addresses Generic Issue C-4). Alternatively, Appendix K to 10 CFR Part 50 contains guidance for conservative ECCS evaluation models. These areas are reviewed as a part of the effort associated with the LOCA analysis (SRP Section 15.6.5). However, the impact of various postulated single failures on the operability of the ECCS, ECCS response times, break locations (including ECCS break locations), and break sizes impacting ECCS capabilities are evaluated under this SRP section.	Conformance with exceptions. Criterion 9 is applied to BWR. BTP 6-5 item E is applied to traditional PWR with a switchover from the injection mode to the recirculation cooling mode.	6.3

Table 1.9.2-6 US-APWR Conformance with Standard Review Plan Chapter 6 Engineered Safety Features (Sheet 25 of 35)

SRP Section and Title	SRP Excerpt Indicating Acceptance Criteria for DCD	Status	Appears in DCD Chapter/Section
6.3 Emergency Core Cooling System (continued)	2. The ECCS must meet the requirements of GDC 35. The system must have alternate sources of electric power, as required by GDC 17, and must be able to withstand a single failure. The ECCS should retain its capability to cool the core in the event of a failure of any single active component during the short term immediately following an accident, or a single active or passive failure during the long-term recirculation cooling phase following an accident. A passive failure in a fluid system is a breach in the fluid pressure boundary or mechanical failure that adversely affects a flowpath. SECY-94-084 states the approved position that passive advanced light-water reactor designs need not assume passive component failures in addition to the initiating failure in the application of single-failure criterion to assure safety of the plant. In addition, the staff considers, on a long-term basis, passive component failures in fluid as potential accident initiators, in addition to initiating events. Check valves in the passive safety systems (except those for which proper function can be demonstrated and documented) are considered components subject to single-failure consideration. 3. The ECCS must be designed to permit periodic inservice inspection of important components, such as spray rings in the reactor pressure vessel, water injection nozzles, piping, pumps, and valves in accordance with the requirements of GDC 36. The ECCS must be designed to permit testing of the operability of the system throughout the life of the plant, including the full operational sequence that brings the system into operation, as required by GDC 37.		

Table 1.9.2-6 US-APWR Conformance with Standard Review Plan Chapter 6 Engineered Safety Features (Sheet 26 of 35)

SRP Section and Title	SRP Excerpt Indicating Acceptance Criteria for DCD	Status	Appears in DCD Chapter/Section
6.3 Emergency Core Cooling System (continued)	4. The combined reactivity control system capability associated with ECCS must meet the requirements of GDC 27 and should conform to the recommendation of Regulatory Guide 1.47. The primary mode of actuation for the ECCS must be automatic, and actuation must be initiated by signals of suitable diversity and redundancy. Provisions should also be made for manual actuation, monitoring, and control of the ECCS from the reactor control room. 5. The design of the ECCS should conform to the recommendations of Regulatory Guide 1.1. 6. Design features and operating procedures, designed to prevent damaging water hammer due to such mechanisms as voided discharge lines and water entrainment in steam lines shall be provided, in order to meet the requirements of GDC 4. 7. The design of those portions of the system which are not safety related, whose failures could have an adverse effect on the ECCS system, must be in accordance with GDC 2, and acceptance is based on meeting Position C2 of Regulatory Guide 1.29. Also see SECY-94-084 for policy and technical issues associated with the regulatory treatment of non-safety systems in passive plant designs. 8. Interfaces between the ECCS and component or service water systems must be such that operation of one does not interfere with, and provides proper support (where required) for, the other. In relation to these and other shared systems, e.g., residual heat removal (RHR) and containment heat removal systems, the ECCS must conform to GDC 5. 9. The requirements of Task Action Plan Item II.K.3(15) of NUREG-0737 and NUREG-0718, which involves isolation of HPCI and RCIC for BWR plants, should also be satisfied. 10. The requirements and guidance regarding ECCS outage times and reports on ECCS unavailability, contained in Task Action Plan Item II.K.3.17, and Generic issue B-61, must also be satisfied.		

Table 1.9.3-1 Conformance with Generic Issues (Sheet 24 of 29)

Issue Number and Title	Summary	Status/Discussion	Addressed in DCD Chapter/ Sec.
New Generic Issue #191 Assessment of Debris Accumulation on PWR Sump Performance NRC priority: HIGH	Results of research on BWR ECCS suction strainer blockage identified new phenomena and failure modes that were not considered in the resolution of Issue A-43. In addition, operating experience identified new contributors to debris and possible blockage of PWR sumps, such as degraded or failed containment paint coatings. Thus, this issue was identified by NRR and called for an expanded research effort to address these new safety concerns. A study was deemed to be required to determine whether PWR ECCS sumps are adequate to ensure proper ECCS operation. Based on the existence of an action plan to address the safety concerns, the issue was considered nearly-resolved in September 1996. It was later given a HIGH priority ranking in SECY-98-166.	~~US-APWR is following up to date methodology for sump design and performance, as summarized below.~~ ▲ ~~***Sump Description*** – Each quadrant of the RWSP contains paired suction piping and the suction pit arrangement for the CSS/RHR pumps and SI pumps. The open end of each suction pipe is equipped with a debris strainer that satisfies NEI 04-07 PWR Sump Performance Evaluation Methodology and conforms to RG 1.82, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident". The suction strainers are designed to Seismic Category I and Quality Class B standards. The debris strainers are a passive disc type design with a large "footprint" that is sufficient to preclude debris clogging. The debris strainers are made of stainless steel and could use perforated plates in a layered disc design to limit the maximum "pass through" debris size to accommodate with downstream design.~~	~~3.8.4.1 (robust Cat I design & construction requirements)~~ , 6.2.2.2.5 ~~(refueling water storage pit),~~ 6.2.2.2.6 ~~and table 6.2.2-1 (ECCS/CS strainers and conformance with RG 1.8.2), Chapter 16 and related Tech Spec document (LCOs relevant to ensuring sump availability and performance)~~

Add "6.2.3"

Replaced with:
"The following assessments were implemented to address GSI-191 issues. The strainer performance was evaluated in accordance with Regulatory Guide 1.82 Revision 3.
- Break selection
- Debris source term
- Debris generation
- Debris characteristics
- Debris transport
- Debris head loss
- NPSH and air injection
- Coating evaluation
- Chemical effects
- Upstream effects
- Downstream effects
- Strainer structural analysis"

Table 1.9.3-1 Conformance with Generic Issues (Sheet 25 of 29)

Issue Number and Title	Summary	Status/Discussion	Addressed in DCD Chapter/ Sec.
New Generic Issue #191 Assessment of Debris Accumulation on PWR Sump Performance NRC priority: HIGH (continued)		~~***Detailed conformance with RG 1.8.2***~~ ~~DCD Table 6.2-1 presents a comparison of the RWSP recirculation intake debris strainer design to the guidance of RG 1.82., addressing the topics of:~~ ▪ ~~General materials and geometry~~ ▪ ~~Minimizing Debris~~ ▪ ~~Instrumentation~~ ▪ ~~In-Service inspection~~ ▪ ~~Evaluation of Alternative Water Sources~~ ▪ ~~Evaluation of Long-Term Recirculation Capability~~ ▪ ~~Debris Sources and Generation~~ ▪ ~~Debris Transport~~ ▪ ~~Debris Accumulation and Head Loss~~ ~~Some highlights from the US-APWR specific response to the RG 1.82 requirements:~~ ▪ ~~Four separate, independent and redundant 50% capacity trains each of CSS and SI are provided. Each quadrant of the RWSP contains paired CSS and SI suction pipes and each pair of CSS and SI suction pipes ends in a suction sump, with each suction sump protected by an associated suction strainer. The RWSP is the common suction source to the ECCS and CSS and contains approximately 607,500 gallons of 4500 ppm boric acid at pH 4.2. Crystalline NaTB is added to raise pH to at least 7 for iodine removal and long term LOCA cooling and recovery. LOCA spillage and spray return flow paths to RWSP promote full mixing.~~	

Table 1.9.3-1 Conformance with Generic Issues (Sheet 26 of 29)

Issue Number and Title	Summary	Status/Discussion	Addressed in DCD Chapter/ Sec.
New Generic Issue #191 Assessment of Debris Accumulation on PWR Sump Performance NRC priority: HIGH (continued)		▲ ~~Containment drains (transfer pipes) into RWSP are protected from large debris by vertical debris bars capped by a ceiling plate. The sump openings (suction strainers) are located at approx. elevation 3'-7" of containment, with CSS and SI suction at approx. 1'-5". Disk-type suction strainer bases are mounted above the RWSP floor.~~ ▲ ~~Suction strainers are to be base mounted above level RWSP floor. Design analysis inputs for debris transport are conservative.~~ ▲ ~~The transfer pipe openings are equipped with vertical debris bars capped by a ceiling plate. The transfer pipes are located in areas of containment where drains will not directly impinge on them.~~ ▲ ~~Vertical debris bars and ceiling plate protecting transfer pipe openings are of robust design and provide adequate protection from missiles and other large debris. Suction strainers are designed to Seismic Category I and Quality Class B standards. Design loads are properly combined and differential pressure caused by potential debris clogging is taken into account as part of mechanical analysis.~~ ▲ ~~Corrosion resistant (stainless steel) material is used for suction strainers and all inner surfaces of the RWSP.~~ ▲ ~~RWSP hatches are provided and suction strainers are designed for inspections.~~ ▲ ~~Strainers are sized appropriately to withstand debris. Because the RWSP has a large floor area, strainers are free from space restrictions and associated debris blockage.~~ ▲ ~~The debris strainers are to be made of stainless steel and will use perforated plates in a layered disc design to limit the maximum "pass through" debris size to accommodate with downstream design.~~	

Table 1.9.3-1 Conformance with Generic Issues (Sheet 27 of 29)

Issue Number and Title	Summary	Status/Discussion	Addressed in DCD Chapter/ Sec.
New Generic Issue #191 Assessment of Debris Accumulation on PWR Sump Performance NRC priority: HIGH (continued)		▲ ~~RWSP suction strainers are submerged under a minimum of approximately 4 ft of water during a LOCA. The RWSP recirculation supply is sufficient to preclude adverse hydraulic effects such as vortex formation and high suction head loss. A low approach velocity at the strainer surface also mitigates the risk of vortexing.~~ ▲ ~~The US-APWR design of ESF structures, systems or components does not include a CSS or SIS suction flow path that bypasses the RWSP suction strainers.~~ ▲ ~~For purposes of minimizing debris, cleanliness, housekeeping and FMEA (foreign material exclusion areas) are administrative controls to be developed by the COL Applicant referencing the certified US-APWR design for construction and operation. Particulate (e.g., calcium silicate based) insulation is excluded from containment by design.~~ ▲ ~~Information on debris produced by chemical reaction between ECCS water sources and containment materials (chemical effects) currently is being developed. Principle measures taken by the US-APWR design to preclude adverse chemical effects include use of buffering agent NaTB, and excluding particulate producing material (e.g., calcium silicate based insulation) from containment.~~ ▲ ~~CS and SI pump operating information is available in the control room to assist in anomalous NPSH evaluation, including flow, suction and discharge pressure, and pump motor current.~~ ▲ ~~In Service Inspections of the sumps and strainers are the responsibility of any licensee who references the US-APWR certified design for construction and operation.~~	

Table 1.9.3-1 Conformance with Generic Issues (Sheet 28 of 29)

Issue Number and Title	Summary	Status/Discussion	Addressed in DCD Chapter/ Sec.
New Generic Issue #191 Assessment of Debris Accumulation on PWR Sump Performance NRC priority: HIGH (continued)		• ~~Calculated cooling performance (10 CFR 50.46(a)(1)(i)) of the US-APWR ECCS and CSS, including Criteria 5, long-term cooling, are addressed in DCD Chapter 15, Transient and Accident Analyses.~~ ▲ ~~Performance of long-term recirculation is evaluated by adopting NEI 04-07 methodology.~~ ▲ ~~The break properties (e.g., sizes, locations) used in the NEI 04-07 methodology are considered for debris generation, and multiple potential debris sources, types and characteristics are considered.~~ ▲ ~~US-APWR analysis conservatively assumes 100% of LOCA-related debris produced reaches the RWSP. Debris quantity calculations consider appropriate transport modes and mechanisms for LOCA phases and conditions, and are consistent with NEI 04-07 guidance and recommendations.~~ ~~RWSP transport and suction strainer performance computations consider appropriate bulk flow velocities and other LOCA-related hydrodynamic phenomena and forces.~~ ~~**Technical Specification LCOs relevant to sump availability and performance**~~ ▲ ~~LCO 3.5.2 and 3.6.6 – Require operability of containment spray system, including containment sumps and screens as part of the flow path, and correct positioning of containment spray isolation valves.~~ ▲ ~~LCO 3.5.4 – Refueling Water Storage Pit – Ensures sufficient water volume exists in the containment sump to support continued operation of the SI and CS/ RHR, and that the sump pH is maintained in an acceptable range.~~	

Table 1.9.3-1 Conformance with Generic Issues (Sheet 29 of 29)

Issue Number and Title	Summary	Status/Discussion	Addressed in DCD Chapter/ Sec.
New Generic Issue #191 Assessment of Debris Accumulation on PWR Sump Performance NRC priority: HIGH (continued)		• ~~LCO 5.0—Administrative Controls—5.5.8, Inservice Testing Program, requires periodic surveillance of safety equipment to ensure functionality, which will include the containment sumps and screens.~~ ~~Conclusions: The US-APWR ECCS will be designed in accordance with Regulatory Guide 1.82, revision 3. Four redundant strainer systems will be installed within the RWSP, which has a broad footprint to obtain sufficient surface area. Particulate insulations such as calcium silicate are excluded from the US-APWR containment, to reduce potential sources of debris that would significantly increase head loss through the sumps. Coatings debris is estimated by the NEI 04-07 methodology, and 200 pounds of latent debris is assumed to reach each strainer location. NaTB is selected as the agent for pH control in the recirculation water inside containment, to mitigate the chemical effect that might be caused during long term cooling. The US-APWR design selects disk type strainer systems that are currently available, avoiding the application of conventional flat screen strainer design.~~	
New Generic Issue #193 BWR ECCS Suction Concerns NRC priority: CONTINUE	Does not apply to US-APWR.	Not applicable to US-APWR design certification. (Applicable only to boiling water reactors (BWRs))	NA

Tier-2

Chapter 5

5.2.3 Reactor Coolant Pressure Boundary Material

exposed to reactor coolant. Field experience proves that Grafoil is compatible with reactor coolant.

5.2.3.2.3 Compatibility of Construction Materials with External Insulation and Reactor Coolant

The US-APWR design utilizes the reflective metal insulation (RMI), to the great extent practical, for the pipe lines and components subject to jet impingement from a high-energy line break, in order to mitigate the generation of insulation debris. RMI is made of stainless steel and applied to most part of the RCS components and piping. (Ref. 5.2-36)

Nonmetallic insulating materials, which may be applied to small segments of pipe line, comply with Regulatory Guide 1.36, "Nonmetallic Thermal Insulation for Austenitic Stainless Steel" (Ref.5.2-11) and American Society for Testing and Materials (ASTM) C795-03, "Standard Specifications for Thermal Insulation for Use in Contact with Austenitic Stainless Steel" (Ref.5.2-26). Use of insulation containing halogen compounds that exceed the limits of Regulatory Guide 1.36 is not permitted by Mitsubishi Heavy Industries, Ltd. (MHI) specifications. The level of leachable contaminants, especially chlorides and fluorides, is maintained at the lowest practicable levels to minimize the potential for SCC.

Chloride and fluoride ions can cause SCC of austenitic stainless steel, while sodium and silicates produce corrosion inhibiting ions. Basically, the balance of contaminant anions and cations determines the severity of SCC. Accidental leakage of fluid through pipe fittings, valves, or nearby equipment could lead to corrosion of the RCPB materials. Therefore, by design, leakage paths of such components have been evaluated to minimize contact with the RCPB materials. In regions where contact cannot be prevented, the insulation is designed to be easily removable to permit more thorough examination.

In the event that ferritic materials are exposed to reactor coolant leakage, the ferritic materials will experience increased general corrosion. Materials compatible with the coolant are used where minor leakage is considered possible based on service experience (such as valve packing, pump seals, etc.). During in service operation, coolant leakage can be detected by monitoring the water level of the container vessel sump. Ferritic materials exposed to coolant leakage can be readily identified by an inservice visual and/or nondestructive inspection program.

5.2.3.3 Fabrication and Processing of Ferritic Materials

5.2.3.3.1 Fracture Toughness

RCPB components are constructed of high durability grade materials. All Class 1 pressure retaining components comply with ASME Code Section III, Article NB-2300 "Fracture Toughness Requirements for Materials". (Ref.5.2-22)

Fracture toughness of ferritic RCPB materials complies with ASME Code Section III, NB-2300 and NB-2400, and the reference nil ductility temperature (RT_{NDT}) of these materials does not exceed 10°F.

Table 5.4.7-2 Equipment Design Parameters (Sheet 1 of 2)

Containment Spray/Residual Heat Removal Pump	
Number	4
Type	Horizontal, centrifugal type
Power Requirement (kW)	400
Design Flow Rate (gpm)	3,000
Design Head (ft)	410
Minimum Flow Rate (gpm)	355
Maximum Flow Rate (gpm)	3,650
Design Pressure (psig)	900
Design Temperature (° F)	400
Material	Stainless Steel
Normal Operating Temperature (° F)	32 ~ 356
Fluid	Reactor coolant, Boric acid water
Radioactive Concentration (kBq/cm^3)	≥ 37
NPSH Available	~~17.9 ft at 3,650 gpm~~
NPSH Required	~~16.4 ft at 3,650 gpm~~
Equipment Class	2

Design-basis

20.9 ft. Note1

19.7 ft.

Note 1 Detail of NPSH available is described in Reference 6-34

5.2-33 S.Asada, et. Al.,PWSCC Life Time Evaluation on Alloy 690, 52 and 152 for PWR Materials, EPRI PWSCC of Alloy 600, 2007 International Conference & Exhibition.

5.2-34 Contents of Applications; Technical Information, NRC Regulations Title 10, Code of Federal Regulations, 50.47.

5.2-35 Operation and Maintenance Code Case Acceptability, ASME OM Code.

5.2-36 US-APWR Sump Strainer Performance, MUAP-08001, ~~Revision 2, December 2008~~.

5.2-37 Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants, Generic Letter 88-05, March 17. 1998.

5.2-38 Control of Preheat Temperature for Welding of Low-Alloy Steel, Regulatory Guide 1.50, Rev.0, May 1973.

5.2-39 Thermal Aging Embrittlement of Cast Austenitic Stainless Steel Components, License Renewal Issue No. 98-0030, May 19, 2000.

5.2-40 Deleted

5.2-41 Minimization of Contamination and Radioactive Waste Generation: Life-Cycle Planning. RG 4.21, Rev.0, U.S. Nuclear Regulatory Commission, Washington, DC, June 2008.

Replaced with "Revision 5, August, 2011"

Subsection 6.1

Engineered Safety Feature Material

pH, corrosive attack of stainless steel alloys used in containment will be insignificant. Similarly, a post-LOCA hydrogen generation (due to material corrosion) is negligible. In addition, the generation of chemical precipitates from aluminum will be minimized. Programmatic controls to limit aluminum in the containment are described in Subsection 6.2.2.3. DCD_06.02.02-63

6.1.2 Organic Materials

With the notable exception of coatings and electrical insulation, organic materials (e.g., wood, plastics, lubricants, asphalt) are not freely available in containment. A primer (e.g., epoxy) typically is applied as a base coating over the steel plate lining of the containment vessel, as well as to structural steel support members. A scuff resistant top coat (e.g., epoxy) is then applied for durability and decontamination considerations. When practical, carbon steel access and support components inside containment (e.g., stairs, ladders, landings, gratings, handrails, ventilation ducts, cable trays) may be hot-dip galvanized. The operating surfaces of components (e.g., valve handwheels, operating handles) are typically factory coated for mechanical durability and resistance to the containment operating environment. These coatings may be dry-powder or water-reduced materials. However, factory application, to sometimes small and complex shapes, under controlled conditions, makes such coatings highly resistant to removal. With rare and minor exception (e.g., protective coatings on trim pieces, faceplates, and covers) coatings used inside containment are applied in accordance with RG 1.54 (Ref. 6.1-12), and meet the applicable environmental qualifications described in Chapter 3, Section 3.11. All organic materials that exist in significant amounts in the containment (e.g., wood, plastics, lubricants, paint or coatings, electrical cable insulation, and asphalt) are identified and quantified in Subsection 6.2.2.3. Coatings not intended for a 60-year service without overcoating should include total overcoating thicknesses expected to be accumulated over the service life of the substrate surface.

Quality assurance programs provide the confidence that safety-related coating systems inside and outside of containment will perform their intended safety functions. This is achieved by controlling procurement, application, and monitoring programs for Service Levels I, II, and III coating systems. Service Level I coating systems satisfy quality requirements provided in ASME NQA-1-1994, ASTM D3843-00, and 10 CFR 50 Appendix B, Criterion IX. Service Level III coating systems satisfy quality requirements provided in ASME NQA-1-1994 and 10 CFR 50, Appendix B, Criterion IX.

The classification of Service Levels for coating systems conforms to guidance provided in RG 1.54 Revision 1 and associated standards.

As stated in RG. 1.54 Revision 1, the scope of the maintenance rule (10 CFR 50.65) includes Safety-Related Structures, Systems, and Components. This also applies to Service Level I protective coatings of any form. Therefore, control and qualification of applied coatings are maintained through monitoring and maintenance programs for protective coating and organic materials, along with adequate implementation of the quality assurance program described above.

Coatings program assures that the effects of protective coatings within scope are monitored, or that its performance is effectively controlled through preventive maintenance. The program includes programmatic bases and guidelines, as well as the

Subsection 6.2

Containment Systems

The system piping is normally filled and vented to the containment isolation valves (CSS-MOV-004A, B, C, and D) at elevation 36.75 ft. (typical for all four 50% containment spray trains) prior to plant startup. The minimum piping "keep full" level corresponds to the RWSP 100% water level at elevation 19.5 ft. A conservative value of 100 seconds time delay is assumed between the system initiation and the spray ring flow for purposes of LOCA and the containment response analyses. The delay time associated with accidents is provided in Subsection 6.2.1.1.3.4 and Table 6.2.1-5.

6.2.2.2.4 Containment Spray Nozzles

The containment spray nozzles are of the type and manufacture commonly used in United States commercial nuclear applications. The nozzles are fabricated from 304 stainless steel, and each is fitted with a 0.375 in. orifice. As shown in Figure 6.2.2-2, the one-piece construction provides a large, unobstructed flow passage that resists clogging by particles, while producing a hollow cone spray pattern. Figure 6.2.2-3 shows each nozzle's orientation on a spray ring. The nozzle orientation is identified as vertical down (No. 1 nozzle, R-5605); 45° from vertical down (No. 3 nozzle, R-5604); and horizontal (No. 2, and No. 4 nozzles, R-5603). Figure 6.2.2-4 presents the spray pattern and typical spray coverage of each nozzle type.

Figure 6.2.2-5 is a sectional view of containment showing the elevation of the spray rings (A, B, C, and D) and the typical spray pattern from the nozzle to the containment operating floor level (elevation 76 ft. - 5 in). Figure 6.2.2-6 presents a plan view showing the location of each nozzle on each spray ring and the predicted spray coverage on the operating floor of the containment. Figure 6.2.2-6 also tabulates the number and orientation of the nozzles on each spray ring. Of the 348 containment spray nozzles distributed among the four containment spray rings, there are only four vertical up No. 4 nozzles (R-5603)—one on each spray ring. In addition to their spray function, these nozzles also serve as the high point vent on each spray ring.

6.2.2.2.5 Refueling Water Storage Pit

The RWSP is the protected, reliable, and safety-related source of boric acid water for the containment spray and SI. (Section 6.3 describes the SI function for the US-APWR ECCS.) The RWSP also is used to fill the refueling cavity in support of refueling operations. The RWSP is located on the lowest floor inside the containment, with a minimum 81,230 ft^3 capability available, it is designed with sufficient capacity to meet long-term post-LOCA coolant needs, including holdup volume losses. Potential holdup areas within the containment are depicted in Figure 6.2.1-9. The transfer piping and refueling cavity drain piping serves to the replenishment functions necessary for the ECCS to perform its safety function. The total water volume held up in the containment is shown in Figure 6.2.2-7. Figure 6.2.2-7 shows the RWSP capacity requirements for refueling and LOCA. The RWSP is configured as a rough horseshoe-shaped box around the containment perimeter. The open end of the RWSP is oriented at the containment 0° azimuth (plant north), where the reactor coolant drain tank, reactor coolant drain pumps, and the containment sump are located. Figure 6.2.1-16 and Figure 6.2.1-17 present plan and sectional views of the RWSP. Subsection 6.2.1 describes the RWSP and its containment-related features and functions as part of the containment structure.

As discussed in Chapter 3, the RWSP is designed as Equipment Class 2, seismic category I, with a maximum operating temperature of ~~250°F~~. Pressure in the RWSP air space is relieved to the containment atmosphere, but the RWSP is ~~designed~~ to withstand a containment pressure of 9.6 psi. (9.6 psi is the differential pressure between containment atmosphere and the RWSP air space during a LOCA.) The inside walls and floor of the RWSP in which contact with 4,000 ppm boric acid solution are lined with stainless steel clad steel plate. The RWSP ceiling (underside of floor at containment elevation 25 ft. - 3 in.) is not normally in contact with the RWSP boric acid water, but is clad with stainless steel plate.

270

The coolant and associated debris from a pipe or component rupture (LOCA), and the containment spray drain into the RWSP through transfer pipes, as shown in Figure 6.2.1-12. The pipes are installed through the RWSP ceiling, ending as openings into the containment floor at elevation 25 ft. - 3 in. Each transfer pipe opening into the containment is protected from large debris by vertical debris interceptor bars that are capped by a ceiling plate. There are ten transfer pipes distributed around the containment at elevation 25 ft. - 3 in, as shown in ~~figure~~ 6.2.1-16. ~~The debris~~ interceptor consists of 6 round vertical rods and 1 top plate ~~is provided~~ at the transfer piping which collect and return recirculation water to the RWSP. The vertical rods are installed at an interval smaller than the inner diameter of transfer piping. This is to prevent transfer pipe from blockage by debris larger than the inner diameter of the pipe. ~~Since the~~ design basis of postulated debris is defined as ~~"small"~~ and all of debris is ~~considered reachable~~ to the RWSP in the ~~safety~~ evaluation of the sump performance (~~Reference~~ 6.2-34). The ~~debris~~ interceptor is not credited to contribute ECC operation, and therefore it is classified as non-safety related, seismic category II component. To minimize containment humidity (due to evaporation from the RWSP), the transfer pipes extend from the containment floor, through the RWSP ceiling to below the normal 100% RWSP water level.

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The RWSP vents are installed through the RWSP ceiling and discharge into the containment atmosphere above. The vents act to equalize the RWSP and the containment free volume air pressure, when the SI pumps or CS/RHR pumps take suction and draw down the RWSP water level. The vents consist of five pairs of vents to mix the RWSP air with the containment free volume air during post-LOCA. Each pair of vent pipes terminates below the normal RWSP water level to minimize the release of vaporized RWSP water into the containment atmosphere during normal plant operation.

As shown in Figures 6.2.2-8 and 6.2.2-9, each quadrant of the RWSP contains paired suction piping and the suction pit arrangements for the CS/RHR pumps and SI pumps. The open end of each suction pipe is equipped with a debris strainer (emergency core cooling/containment spray (ECC/CS) strainer) that satisfies NEI 04-07, "PWR Sump Performance Evaluation Methodology" and conforms ~~to~~ the guidance in RG 1.82 (Ref. 6.2-23).

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Table 6.2.2-2 presents a comparison of the RWSP recirculation intake debris strainer (ECC/CS strainer) design to the guidance of RG 1.82 (Ref. 6.2-23).

The RWSP also is equipped with two spargers (diffusers), which are large stainless steel right circular cylinders that are capped and drilled; each sparger is located near the bottom of the RWSP at containment 90° (plant east) and 270° (plant west) azimuth. The spargers receive, and diffuse into the RWSP water, high-energy (but low volume and

flow) water from emergency letdown lines and CS/RHR pump suction relief valves. The emergency letdown lines (described in Subsection 6.3.2) are directed to separate RWSP spargers. The RWSP is equipped with an overflow pipe to accommodate a level change from such discharges, as shown in Figure 6.2.1-15.

6.2.2.2.6 ECC/CS Strainers

Insert A

~~These components are included in the ECCS. Figures 6.2.2-8 and 6.2.2-9 show four independent sets of ECC/CS strainers located in the RWSP. The strainer design includes redundancy, a large surface area to account for potential debris blockage and maintain safety performance, corrosion resistance, and a strainer hole size to minimize downstream effects. Additional design attributes are described in the US-APWR Sump Strainer Performance document (Ref 6.2-34).~~

As described in Chapter 3, the ECC/CS strainers are Equipment Class 2, seismic category I.

Insert B

6.2.2.2.7 Major Valves

Containment isolation is discussed in Subsection 6.2.4. Control (including interlocks) and automatic features of containment isolation valves are discussed in DCD Chapter 7, Section 7.3.

6.2.2.2.7.1 CS/RHR Pump RWSP Suction Isolation Valve

There is a normally open motor-operated gate valve in each of the four CS/RHR pump suction lines from the RWSP. These valves would remain open during normal and emergency operations. The valves are remotely closed by operator action from the MCR and RSC only if a CSS had to be isolated from the RWSP to terminate a leak or during RHR cooldown operation where the isolation from the RWSP is required. In the pump/valve maintenance, these valves are also closed. The open or closed valve position, for these valves, is indicated in the MCR and RSC. The four CS/RHR pump RWSP suction isolation valves (CSS-MOV-001A, B, C, and D) are Equipment Class 2, seismic category I.

These valves are interlocked and are allowed to open only if the two in-series RHR hot leg suction isolation valves are closed.

6.2.2.2.7.2 Containment Spray Header Containment Isolation Valve

There is a normally closed motor-operated gate valve in each CS/RHR heat exchanger outlet line. These valves are open automatically on receipt of a containment spray signal. The valves can be closed remotely by operator action from the MCR and RSC if containment isolation is required or during RHR cooldown operation where the isolation from the containment spray header is required. The open or closed valve position, for these valves, is indicated in the MCR and RSC. The four containment spray header containment isolation valves (CSS-MOV-004A, B, C, and D) are Equipment Class 2, seismic category I.

These valves are interlocked and are allowed to open only if two in-series RHR hot leg suction isolation valves are closed. In addition, the electrical power for these valves are removed to prevent an inadvertent opening and actuation of containment spray during RHR cooldown operation.

6.2.2.2.7.3 Containment Spray Header Containment Isolation Check Valve

One swing check valve is aligned in each CS/RHR heat exchanger outlet line as containment isolation valve. The containment spray header containment isolation check valve (CSS-VLV-005A, B, C, and D) are Equipment Class 2, seismic category I.

6.2.2.3 Design Evaluation

Because smaller spray droplets fall more slowly and reach equilibrium with vapor more quickly than larger droplets, the US-APWR uses a Sauter mean diameter of 1,000 microns as the assumed droplet size for analysis purposes.

This value is obtained by the following formula:

$$\sum (n \times d^3) / \sum (n \times d^2) \ \mu m$$

The value of the n and d variables are empirical data obtained using the spray nozzle design shown in Figure 6.2.2-2, where:

n = number of droplets in specified diameter range

d = diameter of droplet

While a given mass of drops at the Sauter mean diameter has the same surface to mass ratio as the actual drop spectrum, the consistency of the surface to mass ratio ensures that the heat transfer rate to heat capacity ratio is correctly approximated. Thus, the Sauter mean diameter of 1,000 microns is conservative and possesses a consistent surface to mass ratio for use in the GOTHIC (Ref. 6.2-1, 6.2-2, 6.2-3) computer analysis code.

Insert C

Containment spray patterns, containment spray elevation and plane drawings are provided in Figures 6.2.2-5, 6.2.2-6. These drawings demonstrate adequate coverage and overlap.

~~The Sump Strainer Performance Evaluation document (Ref. 6.2-34) evaluates parameters described in NEI 04-07 (Ref. 6.2-24). Additional detailed evaluation of these parameters is provided in reference 6.2-34 and are summarized below:~~

Insert D

- ~~Identification of insulation types and coating systems used and restricted in the US-APWR and associated potential for debris generation and differential pressure across the strainer~~
- ~~Break selection criteria and bounding break locations~~

- ~~Debris generation, characterization and transport assumptions associated with affected insulation, coatings, and latent debris~~
- ~~Total strainer head loss associated with fibrous and particulate debris, "chemical effect"~~
- ~~Net Positive Suction Head associated with total strainer head loss, hydraulic head loss of the equipment and piping, including uncertainty margins~~
- ~~Upstream effects including hold up volumes conservative drainage flow path and capacity assumptions~~
- ~~Downstream effects potentially impacting the safety functions associated with pumps, valves, heat exchangers, instrumentation (sensing lines and flow measuring devices), spray nozzles, reactor vessel flow paths. Evaluation of downstream effects is described in the report "Sump Strainer Downstream Effects" (Ref: 6.2-36). As for instrumentation, all connections, by design are either at the horizontal or above.~~

Insert E

Insulation is a purchased product and its use is controlled to meet the parameters provided in the US-APWR Sump Strainer Performance document (Ref: 6.2-34).

Insert F

~~The available and required NPSH at the inlet of the CS/RHR and SI pumps are provided in Table 6.2.2-1. Thus, adequate NPSH is provided to the CS/RHR and SI pumps, including margin.~~

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~~Table 6.2.2-1 presents values used in the calculations described above.~~

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Programmatic controls will be established to ensure potential sources of debris introduced into containment (e.g., insulation, coatings, foreign material), and plant modifications will not adversely impact the ECC/CS recirculation function. ~~Programmatic control~~ will be established consistent with guidance provided in RG 1.82, Rev. 3 to ensure that potential quantities of post-accident debris are maintained within the bounds of the analyses and design bases that support Emergency Core Cooling (ECC) and Containment Spray (CS) recirculation functions and ~~ensure~~ the long term core cooling requirements of 10 CFR 50.46 are met. ~~The following is a summary of the programmatic controls that will be implemented to ensure that activities are conducted in a manner that ensures ECC/CS strainer operation, and limits the quantity of latent (unintended dirt, dust, paint chips, and fibers) and miscellaneous (tape, tags, stickers) debris inside containment:~~

These programmatic controls

(Ref.6.2-23), in order

Insert G

to ensure that

Insert H

- Preparation of a cleanliness, housekeeping and foreign materials exclusion program. This program addresses latent and miscellaneous debris inside containment. An acceptance criterion below the conservative assumption of 200 lb for latent debris ~~inside containment will be established consistent with MUAP-08001-P. Sump Strainer Performance Evaluation (Ref.6.2-34).~~ The program will also ensure that the quantity of miscellaneous debris will be limited such that the 200 ft^2 strainer surface area per sump ~~uncertainty~~ per MUAP-08001-P will be met

(Ref. 6.2-40).

Insert I

margin

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to ensure ECC/CS strainer operation. A cleanliness, housekeeping and foreign materials exclusion program will be established by the COL Applicant.

Insert J

- Procedures will be implemented to ensure administrative controls ~~and regulatory/ quality requirements for plant modifications and temporary changes that include consideration of materials introduced into the containment that could contribute to sump strainer blockage.~~ Included will be requirements for controlling temporary modifications to systems, structures and components (SSCs) in a manner which ensures compliance with 10 CFR 50.46. Future plant modifications will be evaluated in accordance with the requirements of 10 CFR 50.59 and 10 CFR 52.63.

- Maintenance activities, including associated temporary changes, will be subject to the provisions of 10 CFR 50.65(a)(4), which requires a licensee to assess and manage the increase in risk that may result from the proposed maintenance activities, prior t maintenance ties. These activities may be shown to be acceptable with respect to the ECC/CS strainers by any of the following means:

  1. performing the activities when the ECC/CS strainers are not required to be operable and restoring conditions consistent with the design bases prior to re-establishing operability;

  conducting a

  2. deterministic evaluation that concludes the specific activities do not create a condition that adversely affects strainer performance;

  controlling the

  3. ~~control of~~ maintenance activities within the bounds established by approved programs that assure no adverse impact (e.g., activities do not result in exceeding limits established for temporary use of material inside containment)~~;~~ , and;

  performing a

  4. risk assessment for a specific activity.

  Combined License Applicant Item COL 17.6(1) addresses development and implementation of the maintenance rule program in accordance with 10 CFR 50.65.

Insert K

- ~~Containment coating monitoring program will be implemented in accordance with the requirements of Regulatory Guide 1.54, Revision 1. Coatings program is described in Subsection 6.1.2.~~

~~Table 6.2.2-3 is a failure modes and effects analysis of the CSS and demonstrates sufficient reliability.~~

~~The containment design heat removal evaluations documented in Subsection 6.2.1.1 includes the effects of the CSS operation (including single failure considerations). Table 6.2.1-5 provides ESF system parameters relating to event sequence such as ECCS and CSS actuation timing. Table 6.2.1-5 also provides both full capacity and partial capacity (used for containment design evaluation) system operation parameters. These evaluations conclude that the acceptance criteria are met. Therefore, the CSS design is~~

~~acceptable. Subsection 6.2.1.1 includes information about the energy content of the containment atmosphere and the recirculation water during the transients that are evaluated.~~

~~Information on the integrated energy content of the containment atmosphere and RWSP water as functions of time following the postulated design basis LOCA and the integrated energy absorbed by the structural heat sinks and CS/RHR heat exchangers is provided in the following Tables and Figures :~~

Insert L

- ~~Table 6.2.1-12, Distribution of Energy at Selected Locations within Containment for Worst-Case Postulated DEPSG Break~~
- ~~Table 6.2.1-14, Distribution of Energy at Selected Locations within Containment for Worst-Case Postulated DEHLG Break~~
- ~~Figure 6.2.1-84, Containment Energy Distribution Transient for DEPSG Break (C_D=1.0)~~
- ~~Figure 6.2.1-85, Containment Energy Distribution Transient for DEHLG Break (C_D=1.0)~~

6.2.2.4 Tests and Inspections

Chapter 14, Section 14.2 "Initial Plant Test Program," is organized and conducted to develop confidence that the plant operates as designed. The initial test program verifies the design and operating features, and gathers important baseline data on the nuclear steam supply system, as well as the balance-of-plant. The baseline data are used to establish the acceptability basis for surveillance and testing during the operational life of the plant. The three phases of the initial test program are as follows:

- Pre-operational tests
- Initial fuel loading and criticality
- low power and power ascension testing

The pre-operational test program tests each train of the CSS. Testing of the CS/RHR pumps using the full flow test line demonstrates the capability of the pumps to deliver the design flow.

Pre-operational tests provide assurance that individual components are properly installed and connected, and demonstrate that system design specifications are satisfied. Pre-operational testing demonstrates that limited interface requirements for support systems are satisfied. Formal review and approval of pre-operational test results (the "pre-operational plateau") are performed prior to initial fuel loading and criticality. The pre-operational test program for the CSS is described in Chapter 14, Subsection 14.2.12.1.

provided in NEI 94-01 (Ref. 6.2-31), as modified and endorsed by the NRC in RG 1.163(Ref. 6.2-30). The results of preoperational and periodic Type A, Band C tests must be documented to show that the performance criteria for leakage have been met. The comparison to previous results of the performance of the overall containment system and of individual components within it must be documented to show that the test intervals established for the containment system and components within it are adequate.

6.2.6.5 Special Testing Requirements

The US-APWR does not have a secondary containment or a sub-atmospheric primary containment, therefore there are no special testing requirements in addition to the requirements of Subsections 6.2.6.1 through 6.2.6.4 above.

6.2.7 Fracture Prevention of Containment Pressure Vessel

Ferritic containment pressure boundary materials include the ferritic portions of the containment vessel and all penetration assemblies or appurtenances attached to the containment vessel; all piping, pumps and valves attached to the containment vessel, or to penetration assemblies out to and including the pressure boundary materials of any valve required to isolate the system and provide a pressure boundary for the containment function.

Ferritic containment pressure boundary materials meet the fracture toughness criteria and requirements for testing identified in Article NE-2000 of Section III, Division 1 (Ref. 6.2-32) or Article CC-2000 of Section III, Division 2 of the ASME Code (Ref. 6.2-33).

6.2.8 Combined License Information

Any utility that references the US-APWR design for construction and Licensed operation is responsible for the following COL items:

COL 6.2(1) *Deleted*

COL 6.2(2) *Deleted*

COL 6.2(3) *Deleted*

COL 6.2(4) *Deleted*

COL 6.2(5) *Preparation of a cleanliness, housekeeping and foreign materials exclusion program is the responsibility of the COL Applicant. This program ~~addresses other debris sources such as latent debris inside containment. This program minimizes foreign materials in the containment.~~*

will be established to limit 200lbs of latent debris, and to limit the allocated 200ft2 of miscellaneous debris per sump.

Insert COL 6.2(6), Preparation of administrative procedures is the responsibility of the COL Applicant. The procedures will ensure that RMI and fiber insulation debris within ZOIs will be consistent with the design basis debris specified in the Table 6.2.2-4, and will ensure that the aluminum in containment exposed to containment spray water is limited to equal or less than 810ft2.

COL 6.2(7) *Deleted*

COL 6.2(8) *The COL Appli*
milestone for th
described under 10 CFR 50, Appendix J.

6.2-11 U.S. Nuclear Regulatory Commission, Interim Staff Position on Environmental Qualification of Safety Related Electrical Equipment, NUREG-0588 Rev 1, November 1980.

6.2-12 Ishii, M., One-Dimensional Drift-Flux Model and Constitutive Equations for Relative Motion Between Phases in Various Two-Phase Flow Regimes, ANL-77-47, October 1977.

6.2-13 Spillman, J.J., Evaporation from Free Falling Droplets, Aeronautical J, 1200:5, pp 181-185, 1984.

6.2-14 General Design Criteria for Nuclear Power Plants, Title 10, Code of Federal Regulations, 10 CFR Part 50, Appendix A, January 2007 Edition.

6.2-15 U.S. Nuclear Regulatory Commission, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, 6.2.1.3 MASS AND ENERGY RELEASE ANALYSIS FOR POSTULATED LOSS-OF-COOLANT ACCIDENTS (LOCAs), Revision 3, March 2007.

6.2-16 Small Break LOCA Methodology for US-APWR, MUAP-07013-P Rev. 2 (Proprietary) and MUAP-07013-NP Rev. 2 (Non-Proprietary), October 2010.

6.2-17 U.S. Nuclear Regulatory Commission, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, 6.2.1.2 SUBCOMPARTMENT ANALYSIS, Revision 3, March 2007.

6.2-18 Subcompartment Analysis for US-APWR Design Confirmation, MUAP-07031-P Rev. 1 (Proprietary) and MUAP-07031-NP Rev. 1 (Non-Proprietary), October 2009.

6.2-19 Non-LOCA Methodology, MUAP-07010-P Rev. 1 (Proprietary) and MUAP-07010-NP Rev. 1 (Non-Proprietary), October 2010.

6.2-20 U.S. Nuclear Regulatory Commission, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, Branch Technical Position 6-2, Minimum Containment Pressure Model for PWR ECCS Performance Evaluation, Revision 3, March 2007.

6.2-21 Construction Testing and Examination, Article CC-5000, ASME Code Section III, Division 2, American Society of Mechanical Engineers, 2004.

6.2-22 Structural Integrity Test of Concrete Containments, Article CC-6000, ASME Code Section III, Division 2, American Society of Mechanical Engineers, 2004.

6.2-23 U.S. Nuclear Regulatory Commission, Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant-Accident, Regulatory Guide 1.82, Rev. 3, November 2003.

6.2-24 Pressurized Water Reactor Sump Performance Evaluation Methodology, Nuclear Energy Institute, NEI 04-07, December 2004.

Volume 1 and 2, including the NRC's Safety Evaluation,

6.2-25 Inservice Testing Requirements, Title 10, Code of Federal Regulations, 10 CFR 50.55a(f), Nuclear Regulator Commission, U.S., Washington, DC, January 2007.

6.2-26 U.S. Nuclear Regulator Commission, Initial Test Programs for Water-Cooled Nuclear Power Plants, Regulatory Guide 1.68, March 2007.

6.2-27 U.S. Nuclear Regulatory Commission, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, 6.2.4 Containment Isolation System Rev. 3, March 2007.

6.2-28 Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors, Title 10 Code of Federal Regulations Part 50, Appendix J, U.S. Nuclear Regulatory Commission, January 2007 Edition.

6.2-29 U.S. Nuclear Regulatory Commission, Control of Combustible Gas Concentrations in Containment, Regulatory Guide 1.7, Rev. 3, March 2007.

6.2-30 U.S. Nuclear Regulator Commission, Performance-Based Containment Leak-Test Program, Regulatory Guide 1.163, September 1995.

6.2-31 Industry Guideline for Implementing Performance-Based Option of 10 CFR Part 50, Appendix J, Nuclear Energy Institute, NEI 94-01, July 1995.

6.2-32 Material, Article NE-2000, ASME Code Section III, Division 1, American Society of Mechanical Engineers, July 2006.

6.2-33 Material, Article CC-2000, ASME Code Section III, Division 2, American Society of Mechanical Engineers, July 2005.

6.2-34 US-APWR Sump Strainer Performance, MUAP-08001-P Rev. 3 (Proprietary), and MUAP-08001-NP Rev. 3 (Non-Proprietary), November 2010.

6.2-35 Containment System Leakage Testing Requirements, American National Standards Institute/American Nuclear Society, ANSI/ANS-56.8-1994, August 1994.

6.2-36 US-APWR Sump Strainer Downstream Effects, MUAP-08013-P Rev. 1 (Proprietary), and MUAP-08013-NP Rev. 1 (Non-Proprietary), January 2011.

6.2-37 US-APWR Probabilistic Risk Assessment, MUAP-07030-P Rev.1 (Proprietary), September 2008.

Insert M

Inserts for DCD Rev. 3 GSI-191 Mark-up

Note: Revision bar indicates those updates from the first GSI-191 tracking report (Refer to MHI letter titled "Transmittal of the US-APWR DCD (Revision 3) GSI-191 Tracking Report (July 2011 version) dated July 29, 2011).

Insert A

These components are included in the ECCS. Figures 6.2.2-8 and 6.2.2-9 show four separate, independent, and redundant 50% capacity sets of ECC/CS strainers located in the RWSP. Only two of the four safety trains are conservatively assumed for evaluating pump performance during an accident. A passive disk layer type of strainer system with nominal 2,754 ft^2 of surface area per sump (or 5,508 ft^2 for two strainer trains) is applied. A minimum of 2,730 (ft^2) per sump accounted for fabrication tolerance will be constructed in the plant. The strainer is principally constructed of perforated plate with a square flange at the bottom for attachment to the supporting plate, which covers the sump pit. The strainers and supporting plates are constructed of corrosion-resistant stainless steel. The nominal diameter of holes is designed to be equal to or less than 0.066", consistent with the narrowest gap in the systems downstream of the strainer.

The strainer design (Figures 6.2.2-8 and 6.2.2-9) is composed of modular components, and is consistent with Regulatory Guide (RG) 1.82 (Ref. 6.2-23) guidance as follows (also, see Table 6.2.2-2, "Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements"):

- Four independent sets of strainer systems are provided inside the in-containment refueling water storage pit (RWSP) and are designed to be fully submerged during all postulated events requiring the actuation of the ECCS with a minimum RWSP water level of 1-ft above the top of the strainer,
- The ECC/CS strainers limit debris from entering the safety systems that are required to maintain the post-LOCA long term cooling,
- The design precludes the water that drains into the RWSP from impinging directly on the strainers,
- The strainers are well isolated from postulated pipe break jets and missiles,
- The strainers' large surface area provides low flow rate on the strainer surface, thus minimizing head loss from debris accumulation,
- The perforated plates are designed to prevent flow blockage and to assure core cooling,
- The strainers are constructed of corrosion resistant materials,
- The strainers are sized to maintain the performance of the safety-related pumps,
- The strainers are designed to meet seismic category I requirements, and
- When operational, the strainers are to be periodically inspected during plant shutdowns.

Insert B

Principal design features of the strainers are provided in Table 6.3-5. Additional design attributes are described in the US-APWR Sump Strainer Performance document (Ref 6.2-34), Subsection 6.2.2.3 "Design Evaluation," Table 6.3-5 "Safety Injection System Design Parameters," and in the associated referenced documents listed in Section 6.2.9 that include References 6.2-36, and 6.2-38.

Insert C

Table 6.2.2-3 is a failure modes and effects analysis of the CSS and demonstrates sufficient reliability.

The containment design heat removal evaluations documented in Subsection 6.2.1.1 includes the effects of the CSS operation (including single failure considerations). Table 6.2.1-5 provides ESF system parameters relating to event sequences such as ECCS and CSS actuation timing. Table 6.2.1-5 also provides both full capacity and partial capacity (used for containment design evaluation) system operation parameters. These evaluations conclude that the acceptance criteria are met, and the CSS design is acceptable. Subsection 6.2.1.1 includes information about the energy content of the containment atmosphere and the recirculation water during the transients that are evaluated.

Information on the integrated energy content of the containment atmosphere and RWSP water as functions of time following the postulated design basis LOCA and the integrated energy absorbed by the structural heat sinks and CS/RHR heat exchangers is provided in the following Tables and Figures:

- Table 6.2.1-12, Distribution of Energy at Selected Locations within Containment for Worst-Case Postulated DEPSG Break
- Table 6.2.1-14, Distribution of Energy at Selected Locations within Containment for Worst-Case Postulated DEHLG Break
- Figure 6.2.1-84, Containment Energy Distribution Transient for DEPSG Break (C_D=1.0)
- Figure 6.2.1-85, Containment Energy Distribution Transient for DEHLG Break (C_D=1.0)

Insert D

The Sump Strainer Performance (Ref. 6.2-34) and Downstream Evaluation (Ref. 6.2-36) reports address Generic Safety Issue (GSI) 191. The key information essential to address GSI-191 is summarized in the following subsections.

6.2.2.3.1 Break Selection

The US-APWR design considers potential pipe breaks in the primary coolant system piping, loss of coolant accident (LBLOCA), and relies on the ECCS sump recirculation for its mitigation. Also, the reactor coolant system (RCS) piping small break LOCAs (SBLOCAs) require ECC/CS sump recirculation. In addition, the secondary side system pipe breaks (i.e., Main Steam and Feed Water (MS/FW)) require sump operation.

The break sizes of the primary and secondary pipe breaks considered are double ended guillotine breaks (DEGB). The basis for this break size selection is to provide the largest volume of debris from insulation and other materials that may be within the region affected by the postulated break. For the break selection, the following break location criteria, which are recommended in the SE of NEI 04-07 and comply with RG 1.82, are considered:

1. Pipe break in the RCS or MS/FW with the largest potential for debris;

2. Large breaks with two or more different types of debris;
3. Breaks with the most direct path to the sump;
4. Large breaks with the largest potential particulate debris to insulation ratio by weight, and;
5. Breaks that generate a "thin-bed," high particulate with 1/8-inch thick bed.

Ref. 6.2-34 applies the criteria above and concludes that the MCP break, 31-inch ID, is the limiting break location in terms of debris generation, transport and head loss for the strainer.

Insert E

6.2.2.3.2 Debris Source Term

The debris source term of the US-APWR that challenges sump performance consists of non-chemical debris (insulation, coatings, latent fiber, sludge, miscellaneous debris such as stickers, tape, etc.) and chemical debris (including aluminum) in the containment. The chemical debris that would precipitate during long-term core cooling is determined by the US-APWR chemical effects tests (Ref. 6.2-38). Also, refer to Section 6.1.1.2.3, "Compatibility of Construction Materials with Core Cooling Coolants and Containment Spray," which denotes that the use of aluminum within containment is limited to minimize the generation of chemical debris during an accident.

The principal insulation used in the containment is reflective metal insulation (RMI). RMI is used for the reactor vessel, steam generators, pressurizer, primary and secondary main and branch lines, and other equipment and piping that require insulation in areas that are potentially subject to jet impingement from high-energy line breaks (HELB). The use of fibrous insulation is eliminated from the ZOI. Pre-formed, buoyant-type insulation is used as anti-sweat insulation chiller piping. The buoyant insulation is not considered to challenge strainer performance for plants with fully submerged strainers per the SE of NEI 04-07 since this debris would not transport to the strainer, and therefore it is excluded from debris source.

Insert F

Methods used to attach insulation to piping and components in containment are as follows:

- Reflective Metal Insulation (RMI) consists of pre-fabricated units (metal jackets) engineered as integrated assemblies to fit the surface that is being insulated. The RMI insulation is supported by the insulated surface or by existing lugs or brackets. Welding is not allowed to attach insulation to the insulated surface. The metal jackets are provided with quick-release latches, closure handles and positive-lock type latches as required.

- Anti-sweat Insulation forms a system comprised of pre-fabricated units (modules or panels) engineered as integrated assemblies to fit the insulated surface. This insulation is held in place with sealant or equivalent.

As discussed in Subsection 6.1.2, DBA-qualified epoxy coatings are applied in the containment in accordance with RG 1.54 (Ref. 6.2-41).

Insert G

Table 6.2.2-2 presents a comparison of the RWSP sump strainer design to the guidance of RG 1.82. Also, refer to Subsection 6.2.2.3.12 and 6.2.2.3.13, "Downstream Effects – In-Vessel/Ex-Vessel."

Insert H

The following is a summary of the programmatic controls that will be implemented to ensure that activities are conducted in a manner that ensures ECC/CS strainer operation, and limits the quantity of latent (unintended dirt, dust, paint chips, and fibers) and miscellaneous (tape, tags, stickers) debris inside containment:

Insert I

(unintended dirt, dust, paint chips, and fibers which principally consist of fiber and particulate debris) inside containment will be established consistent with MUAP-08001-P Sump Strainer Performance Evaluation (Ref.6.2-34).

Insert J

are established for regulatory and quality requirements, for plant modifications and temporary changes, which include consideration of debris source term (i.e., RMI insulation, fiber insulation, inventory of: aluminum, latent debris and miscellaneous debris) introduced into the containment that could contribute to sump strainer blockage. The procedure will ensure that the quantity of RMI and fiber insulation within the ZOIs will be consistent with the design basis debris described in the Table 6.2.2-4, and will ensure that the aluminum in containment exposed to containment spray water is limited to equal or less than 810ft^2.

Insert K

- A containment coating monitoring program will be implemented in accordance with the requirements of Regulatory Guide 1.54, Revision 2 (Ref. 6.2-41). The coatings program is described in Subsections 6.1.2 and 6.2.2.3.9. The chemical effects program is covered in Subsection 6.2.2.3.10 (Ref. 6.2-38).

Insert L

6.2.2.3.3 Debris Generation

The SE of NEI 04-07 guidance report (GR) (Ref. 6.2-24) and the NRC letters to NEI (Ref. 6.2-46 and 6.2-47) are used to determine the zone of influence (ZOI) for generating debris. The diameter of the ZOI for RMI debris generation is 2 inside diameters of the worst-case break line and 4 inside diameters for coating debris. For the sump performance evaluation, the design basis debris quantities are based on the following:

- For RMI insulation, all insulation on a cross-over leg (CO/L) is considered to generate debris.

- No design fiber insulation debris is generated within the ZOI. As an operational margin for future plant modification, fiber insulation debris is assumed and included in the strainer design.

- For coating debris, the generated debris volume is based on the surface area for the ZOI from the main coolant pipe break and a conservative coating thickness. As an operational margin for the plant, an additional amount of coating debris is assumed and included in the strainer design.

For latent debris, 200 lbs of fiber and particulate is applied, as recommended in the guidance (Ref. 6.2-24). Specific material types for miscellaneous debris, such as tapes, tags or stickers, reaching the strainer are not specified. Instead, a 200 ft^2 penalty of sacrificial strainer surface area per sump is considered as a margin for future detailed design and installation. These debris sources are controlled by the foreign material exclusion program that will be established by the plant owner.

The design basis debris for sump strainer performance is summarized in Table 6.2.2-4. More detailed information is provided in the Sump Strainer Performance Evaluation document (Ref. 6.2-34).

6.2.2.3.4 Debris Characteristics

The US-APWR assumes that all fiber debris within the ZOI is "fines". The specification of debris characteristics used for the sump performance evaluation is determined based on the SE of NEI 04-07. (Ref.6.2-24). The SE classified fibrous debris into four groups as follows:

1. fines that remain suspended,
2. small piece debris that are transported along the floor,
3. large piece debris with the insulation exposed to potential erosion, and
4. large debris with the insulation undamaged but still protected by a covering and thereby preventing erosion.

Fine fiber debris is considered suspended and transportable to the strainer. The Post-LOCA 30-day erosion of small fiber debris into fines does not require consideration, because all fiber debris is already assumed to be fine.

RMI insulation debris is assumed to consist of 75 percent small fines and 25 percent large pieces, in accordance with the SE of NEI 04-07. (Ref 6.2-24). The RMI debris is considered as "non-suspended" in the sump pool due to its specific gravity. For RMI debris characterization, the effect of erosion during the 30 days of Post-LOCA operation is not required.

Coating debris within the ZOI is assumed to consist of 100 percent fines, in accordance with the SE of NEI 04-07. (Ref. 6.2-24). The effect of erosion is not considered for coating debris because coating debris is defined as fines.

The latent debris characteristics are based on the SE of NEI GR (Ref 6.2-24). Latent fiber comprises 15 percent (by mass) of the total latent debris loading (i.e., 200 lbs). The latent fiber is comparable to fiberglass "NUKON" insulation and is considered to be fines, as discussed above. The remainder of the latent debris consists of particulate debris, such as latent dust and dirt. Size distribution for latent particulate debris is based on the guidance found in NUREG CR-6877 (Ref.6.2-39). The effect of erosion is not required to be considered for latent debris.

6.2.2.3.5 Debris Transport

Debris transport is the estimation of the fraction of debris that is transported from debris sources (break location) to the sump strainer. The US-APWR assumes that all debris generated in the containment is transported to operable sumps. No debris entrapment in containment is credited in the debris transport evaluation.

The US-APWR has four ECC/CS trains with an independent strainer for each train. The design requires a minimum of two trains in operation, thereby assuming one train is out of service due to on-line maintenance and another one has a single failure. Therefore, transported debris in the sump pool is assumed to be distributed to two, three, or four sumps. The number of operable sumps during LOCA is a key parameter to determine the debris distribution to each sump. This logic establishes the conditions for subsequent evaluations.

For the strainer head loss evaluation, the number of available sumps should maximize the head loss, i.e., assume only two operable sumps. For the bypass debris, the number of operable sumps should maximize the amount of bypass debris, i.e., assume four operating sumps. A more detailed discussion is prepared in the Sump Strainer Performance document (Ref 6.2-34).

6.2.2.3.6 Debris Head Loss

The design basis strainer head loss (i.e., 4.0 ft of water at 120° F) is established to evaluate available Net Positive Suction Head (NPSH) of ECC/CS pumps (See section 6.2.2.3.7). The prototypical strainer head loss tests (Ref. 6.2-34) support the design basis strainer head loss with margin.

6.2.2.3.7 Net Positive Suction Head

From the Sump Strainer Performance Evaluation (Ref. 6.2-34), available Net Positive Suction Head (NPSH) was calculated using the most limiting conditions applicable to all events. For the NPSH available calculation, the containment pressure is assumed equal to the initial containment pressure prior to the start of the accident for low temperatures (sump fluid temperatures below the saturation temperature corresponding to the initial containment pressure). At low temperatures, this methodology fulfills the requirements of RG 1.1 & RG 1.82 that the NPSH available be evaluated without crediting any increase in containment pressure resulting from accident conditions. This approach ensures that sufficient containment pressure is available under all accident conditions and that defense-in-depth is maintained by preserving the independence of systems designed to prevent accidents and those designed to mitigate the effects of accidents.

For temperatures higher than this initial saturation pressure, the containment pressure is conservatively assumed to be equal to the sump fluid vapor pressure. This assumption is independent from the calculated increases in containment accident pressure; instead, the assumed containment pressure is dependent on the RWSP fluid temperature itself. No containment overpressure above the fluid saturation pressure is credited (i.e., the containment pressure is assumed to equal the saturation pressure corresponding to the sump water temperature). The contribution to plant risk from this assumption is discussed further in Section 19.1.7.

In accordance with the above methodology, the NPSH available exceeds the NPSH required for all expected sump temperatures. Therefore, the RWSP strainer and US-APWR design provide

sufficient available NPSH, with adequate strainer submergence, to ensure reliable operation of ECCS and CSS pumps. Further details and conservative assumptions are described in the Sump Strainer Performance Evaluation document (Ref. 6.2-34).

6.2.2.3.8 Vortexing, Sump Fluid Flashing, and Deaeration

Vortexing, Sump Fluid Flashing, and Deaeration are additional issues associated with the NPSH calculation and sump strainer performance that are addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34). These effects are analyzed for short-term, interim, and long-term post-LOCA recirculating conditions.

For vortexing, the strainer meets the NRC guidance for vortex prevention for advanced strainer configurations, based on minimum submergence. Furthermore, the strainer design is expected to exceed the level of vortex prevention provided by minimum submergence alone, due to the low approach velocities, small hole size of the perforated plate, and overall stacked-disc geometry. This has been validated by testing (Ref 6.2-34).

For sump fluid flashing, the strainer is designed with sufficient submergence to preclude the occurrence the two-phase flow at the debris bed which can result in an unacceptable increase in strainer head losses. Air ingestion due to sump fluid flashing is not expected to occur, and therefore it will not adversely affect pump performance. (Ref. 6.2-34).

For deaeration, air solubility at the strainer and pump elevations was evaluated. Significant levels of deaeration (i.e., void fraction) were not expected at either elevation (Ref 6.2-34). The air ingestion due to deaeration is not expected to adversely affect strainer performance or pump performance. The design basis NPSH requirement of the pumps is defined appropriately to account for the void fraction.

6.2.2.3.9 Coatings Evaluation

The US-APWR utilizes a DBA qualified and acceptable coating system in containment.
These coating systems meet the requirements of Service Level-I coatings categorized in USNRC Regulatory Guide 1.54 Revision 1 (Ref, 6.2-41) and the related ASTM requirements described in RG 1.54. The criteria for those coating systems are contained in ANSI N101.2, "Protective Coatings (Paints) for Light Water Nuclear Reactor Containment Facilities" (Ref. 6.2-42), and its successor document, ASTM D 3911, "Standard Test Method for Evaluating Coatings Used in Light-Water Nuclear Power Plants at Simulated Design Basis Accident (DBA) Conditions" (Ref. 6.2-43). Only the epoxy type coatings (including primer and top coat) are used (refer to Section 6.1.2).

6.2.2.3.10 Chemical Effects Test

Chemical effects testing was performed for the US-APWR post-LOCA chemistry conditions to evaluate the transition temperature at which chemical precipitates are expected to form (Refs. 6.2-38, 6.2-44 and Appendix C of Ref. 6.2-34 "Evaluation of Chemical Debris (for head loss)"). Based on the results of this test, the US-APWR sump strainer evaluation credits no precipitation of chemical debris above 150°F. This transition temperature is further confirmed analytically as discussed in the Sump Strainer Performance Evaluation (Ref. 6.2-34).

6.2.2.3.11 Upstream Effect

Evaluation of the upstream effects is performed to identify flow paths leading to the RWSP which could become blocked and potentially hold-up the return water (creating ineffective pools) and, therefore, challenge the RWSP minimum water level evaluation. A partial sectional view of the RWSP concrete structure is shown in Figure 6.2.1-8. (Section 6.2.2.2.5 describes the RWSP function.) An outline of the paths that fluids from the ECCS and CSS would follow in a post-LOCA event and the formation of ineffective pools and potential holdup areas within the containment are shown in Figure 6.2.1-9. Figure 6.2.1-10 shows the volume of ineffective pools. Two return pathways were identified as possible choke points for the returning flow: 1) refueling cavity drains and 2) transfer pipes of the RWSP. The RWSP water level is shown in Figure 6.2.1-11. Also see Figures 6.2.1-12, 6.2.1-13, 6.2.1-14, and 6.2.1-15 for descriptions of transfer pipe debris interceptors, refueling cavity drain lines, and overflow lines. For the reactor cavity drains, the following gratings are credited for preventing "large debris" from reaching and potentially blocking the cavity drains:

- Grating inside the secondary shield wall at EL. 55'-1" (Loop-A,B,C, and D);
- Grating inside the secondary shield wall at EL. 73'-1" (Loop-A,B,C, and D); and,
- Grating at upper core internal laydown pit (in the refueling cavity)

The RWSP transfer pipes are protected by debris interceptors with spacing intervals that are smaller than the inner diameter of the transfer pipes (see Figure 6.2.1-12). The number and size of the reactor cavity drains and RWSP transfer pipes are shown to have sufficient drain capacity per the Sump Strainer Performance Evaluation (Ref. 6.2-34). Besides the transfer pipes and refueling cavity drains, no other drains or narrow pathways are credited for providing make-up to the RWSP. Floor drain piping which directs fluid to the containment sump, such as the SG compartment floor and the operating floor, is assumed to become blocked. Blockage of these floor drains and the effect on calculated holdup-volumes is discussed in further detail in the Sump Strainer Performance Evaluation (Ref. 6.2-34).

The design basis minimum water level of the RWSP is 4.0 ft above the RWSP floor as shown in Figure 6.2.1-11, "RWSP Water levels." The minimum water level for a SBLOCA is bounded by the LBLOCA level.

6.2.2.3.12 Downstream Effects – Ex-Vessel

Assessment of the downstream effects, caused by post-LOCA operation with debris laden fluid for the US-APWR systems and components downstream of the sump strainer, is discussed in the Sump Strainer Downstream Effects report (Ref. 6.2-36) and Chapter 4, "Downstream Effects" of Ref. 6.2-34, "Sump Strainer Performance."

Downstream systems and components include the Emergency Core Cooling System, Containment Spray System and the reactor core (see Subsection 6.2.2.3.13). Evaluation of the ECCS, CSS and their components concludes that these systems are fully capable of performing their intended functions under post-LOCA operating conditions. That is, the ECCS and CSS are fully capable of providing adequate core cooling to ensure the reactor core is maintained in a safe, stable condition following a LOCA.

6.2.2.3.13 Downstream Effects – In-Vessel

The US-APWR plant is designed to facilitate core cooling during a LOCA. Some portions of the chemical precipitates, fibrous and particulate debris generated in the containment vessel during a LOCA are prevented from flowing downstream into the reactor core. However, some of the debris may bypass the sump strainers and ultimately reach the reactor core. Due to this possibility, sump strainer downstream effects were assessed per Ref. 6.2-36. In this report, the evaluation of the effect of downstream debris build-up on long term core cooling demonstrates that the maximum temperature at the fuel cladding surface is below the acceptance temperature. This report also shows that chemical induced local blockages, or scale formation, on the fuel cladding surface of the reactor fuel, will not affect adequate decay heat removal capability.

Cladding temperatures are maintained below those required by Section 50.46 of Title 10 of the Code of Federal Regulations (10 CFR) and Ref. 6.2-48. Therefore, the ECCS and CSS are fully capable of providing adequate core cooling to ensure the reactor core is maintained in a safe, stable condition following a LOCA.

6.2.2.3.14 Sump Structural Analysis

The US-APWR strainer design by PCI, Sure-Flow Strainer (SFS), is based on proven design principles that were implemented in various operating plants. A description of the strainers is provided in Sub-section 6.2.2.2.6, "ECC/CS Strainers." An evaluation of the structural components of the Emergency Core Cooling (ECC) and Containment Spray (CS) Systems sump strainer assembly was performed (Ref. 6.2-49).

The strainers consist of a series of perforated plate disks "sandwiched" onto a central core tube with gap spacers, tension rods and seismic rods to keep the required spacing between disks and maintain the stability of the structure (see Figure 1 of Reference 6.2-49). The ECC/CS sump strainer assembly is composed of the following two sub-assemblies:

1) A strainer stack assembly is composed of 21 individual disks fabricated from perforated stainless steel sheet and bolted together in vertical stacks. The disks are separated by spacers to form a stacked disk configuration. Each strainer stack has an interior core tube which channels the flow of water down to the underlying plenum. There are 9 vertical strainer stacks per sump, and each is supported by its own stainless steel plenum assembly. See Figures 3 and 8 of Reference 6.2-49.

2) A stainless steel plenum for each sump spans the top of the sump opening and provides structural support for the strainer stacks. The plenum also serves to direct the flow from each of the nine strainer stacks to the sump opening. The plenum fits tightly to the containment floor to form a seal and prevent debris from entering the sump.

Analysis of the strainer assembly was performed by using elastic methods for the defined loads. The structural qualification of the strainer assembly was performed using a combination of manual calculations and finite element analyses. The allowable stresses are primarily based on the ASME Code (Ref. 6.2-50) and are supplemented, as required, for stresses induced by special components or loading conditions. The strainer assemblies are considered part of the pressure boundary, Equipment Class 2, for the ECC and CSS systems because they function to prevent debris from entering these systems.

Equipment Class 2 components are analyzed in accordance with the ASME Code, Section III, Class 2 rules. Therefore, the detailed strainer evaluations were performed using the rules of the ASME Boiler and Pressure Vessel Code, Class 2 Components, as presented in ASME Section III, Division 1, Subsection NC. The structural support components were evaluated as component supports per Subsection NF-3350. The Strainer Stress Report (Ref. 6.2-49) concluded that all components of the sump strainer are in compliance with the requirements of the ASME Code, 2001 edition, up to and including the 2003 Addenda (Ref. 6.2-50).

Insert M

6.2-38 US-APWR Sump Debris Chemical Effects Test Result, MUAP-08011-P Rev.0 (Proprietary), November 2008.

6.2-39 Characterization and Head-Loss Testing of Latent Debris from Pressurized Water Reactor Containment Buildings, NUREG/CR-6877, USNRC.

6.2-40 NRC Staff Review Guidance Regarding GL 2004-02 Closure in the Area of Strainer Head Loss and Vortexing, March 2008, USNRC, NRR.

6.2-41 Service Level I. II. and III Protective Coatings Applied to Nuclear Power Plants, Regulatory Guide 1.54 Revision 1, July, 2000, USNRC.

6.2-42 Protective Coatings (Paints) for Light Water Nuclear Reactor Containment Facilities, ANSI N101.2.

6.2-43 Standard Test Method for Evaluating Coatings Used in Light-Water Nuclear Power Plants at Simulated Design Basis Accident (DBA) Conditions, ASTM D 3911.

6.2-44 WCAP-16530-NP, Topical Report "Evaluation of Post-Accident Chemical Effects on Containment Sump Fluids to Support GSI-191 (ML073521072).

6.2-45 U.S. Nuclear Regulatory Commission, Regulatory Guide 1.54, Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants. Revision 2.

6.2-46 Letter from William H. Ruland (NRR) to Alexander Marion (NEI) dated April 6, 2010, Revised Guidance regarding Coatings Zone of Influence for Review of Final Licensee Responses to Generic Letter 2004-02, Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized Water Reactors. (ML100960495)

6.2-47 Letter from William H. Ruland (NRR) to Alexander Marion (NEI) dated July 29, 2010, Draft version of Table 3-2 for protective coating ZOIs including NEI 04-07. (ML100900172)

6.2-48 Letter from Thomas O. Martin (NRR) to J.A. Gresham (WEC) dated July 14, 2006, Nuclear Regulatory Commission Response to Westinghouse Letter LTR-NRC-06-46 regarding Pressurized Water Reactor (PWR) Containment Sump Downstream Effects. (ML062070451)

6.2-49 US-APWR Sump Strainer Stress Report, MUAP-08012-NP (R1), March 2011.

6.2-50 ASME Boiler & Pressure Vessel Code, Section III, Division 1, 2001 edition, up to and including 2003 Addenda.

Table 6.2.1-3 RWSP Design Features

Parameters	Value	
Nominal Liquid Surface Area	4985 ft^2	
Normal Liquid Volume (Water volume of 96 % water level excluding water below 0% level)	~~584,000 gallons~~590,000 gallons	DCD_06.02.02-64
Return Water on the Way to RWSP (During a postulated accident)	~~137,000 gallons~~136,000 gallons	DCD_06.02.02-64
Ineffective Pool	~~297,000 gallons~~310,000 gallons	DCD_06.02.02-64
Minimum Liquid Volume	~~149,000 gallons~~145,000 gallons	DCD_06.02.02-64

76,600 ft3 (573,000 gallons)

18,200 ft3 (136,000 gallons)

41,300 ft3 (309,000 gallons)

17,100 ft3 (128,000 gallons)

Table 6.2.1-5 Engineered Safety Feature Systems Information (Sheet 1 of 2)

US APWR Specification	Value	
	Full Capacity	Value Used for Containment Design Evaluation
I. Passive Safety Injection System		
A. Number of Accumulators	4	4
B. Pressure, psig	695	586
II. Active Safety Injection Systems		
A. High Head Injection System (HHIS)		
1. Number of Lines	4	2
2. Number of Pumps	4	2
3. Flow Rate, gpm/train *	1,540	1,259
4. Response Time, sec (after analytical limit of SI signal reached)	N/A	118
III. Containment Spray System (CSS)		
A. Number of Lines	4	2
B. Number of Pumps	4	2
C. Number of Headers	1	1
D. Flow Rate, gpm	9,800 (4 pumps)	5,290 (2 pumps)
E. Response Time, sec (after analytical limit of SI signal reached)	N/A	243
IV. Refueling Water Storage Pit (RWSP)		
A. Liquid volume. Gallons	~~651,000~~654,000	329,000
B. Liquid surface area ,ft^2	4,985	Interface Area is Ignored
V. Containment		
A. Free Volume (Air Volume), ft^3	2,800,000	2,743,000

DCD_06.02.02-64

Notes:
* HHIS flow rate is the value when RCS pressure is at 0psig.
Hot leg switch-over is conservatively not assumed, which leads to ignoring steam condensation with the hot leg injection.

Table 6.2.2-1 Input Values Employed in CSS Evaluation Calculations

CSS SPRAY NOZZLES	
Quantity	348
Type	Ramp Bottom, 0.375 in orifice
Spray Pattern	Hollow Cone
Flow per Nozzle	15.2 gpm at 40 psig
Material	Stainless steel
CS/RHR PUMP NPSH EVALUATION	
~~$h_{Static\ Head}$~~	~~29.7 ft.~~
~~$h_{line\ loss}$~~	~~7.1 ft.~~
~~$h_{ECC/CS\ strainer}$~~	~~≤4.7 ft.~~ ~~Note 1~~
$NPSH_{available}$	~~17.9 ft.~~ 20.9 ft. Note1
$NPSH_{required}$	~~16.4 ft.~~ 19.7 ft
SI PUMP NPSH EVALUATION	
~~$h_{Static\ Head}$~~	~~29.7 ft.~~
~~$h_{line\ loss}$~~	~~3.1 ft.~~
~~$h_{ECC/CS\ strainer}$~~	~~≤4.7 ft.~~ ~~Note 1~~
$NPSH_{available}$	~~21.9 ft.~~ 20.9ft. Note1
$NPSH_{required}$	~~15.7 ft.~~ 18.8 ft

Delete

Delete

Delete

Insert "Design basis"

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Insert "Design basis"

Note 1 - ~~Contains head loss due to debris clogging and chemical effect.~~

Replace with "Detail of NPSH available is described in Reference 6-34."

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 2 of 17)

No.	Regulatory Position	US-APWR Design
1.1.1.3	The sumps should be located on the lowest floor elevation in the containment exclusive of the reactor vessel cavity to maximize the pool depth relative to the sump screens. The sump outlets should be protected by appropriately oriented (e.g., at least two vertical or nearly vertical) debris interceptors: (1) a fine inner debris screen and (2) a coarse outer trash rack to prevent large debris from reaching the debris screen. A curb should be provided upstream of the trash racks to prevent high-density debris from being swept along the floor into the sump. To be effective, the height of the curb should be appropriate for the pool flow velocities, as the debris can jump over a curb if the velocities are sufficiently high. Experiments documented in NUREG ICR-6772 and NUREGICR-6773 have demonstrated that substantial quantities of settled debris could transport across the sump pool floor to the sump screen by sliding or tumbling.	~~Containment drains (transfer pipes) into the RWSP are protected from large debris by vertical debris bars capped by a ceiling plate. The sump openings (suction strainers) are located at approximately elevation 3 ft. 7 in. of containment, with CSS and SI suction at approx. 1 ft. 5 in. Disk, type suction strainer base mounted above the RWSP floor to be used, with 0.066 in hole diameter.~~ ~~Strainer surface area of approximately 2,754 ft^2 each to reduce the flow velocity and resist clogging, with sufficient recirculation flow and submergence to preclude vortexing.~~
1.1.1.4	The floor in the vicinity of the ECC sump should slope gradually downward away from the sump to further retard floor debris transport and reduce the fraction of debris that might reach the sump screen.	~~Suction strainer to be base mounted above level RWSP floor. Design analysis inputs for debris transport are conservative.~~

Replace with:
"The RWSP containing sump strainers is located on the lowest floor elevation in the containment. The RWSP is designed so that the strainers are fully submerged during all accident conditions. A passive disk layer type of strainer system is employed, instead of the conventional double screen design with a finer screen and trash rack. The strainer is mounted on the base plate installed on the RWSP floor. A curb is not required in the RWSP because the strainer is designed for safe operation with all design basis debris accumulating on the strainer surface. The strainer design takes no credit for debris settling in the transport evaluation. This has been validated by testing."

Replace with:
"The strainer does not require a floor slope because it is designed for safe operation with all design basis debris accumulating on the strainer surface. This has been validated by testing. A slope is provided around the RWSP transfer pipes which drain water from the lowest floor of containment into the RWSP."

Replaced with:
"A conventional sump strainer with a flat cover plate is not applied. A passive disk layer type strainer is used, and designed to withstand debris loads when all design basis debris accumulates on the strainer surface."

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris (Sheet 4 of 17)

No.	Regulatory Position	US-APWR Design
1.1.1.7	Where consistent with the overall sump design and functionality, the top of the debris interceptor structures should be a solid cover plate that is designed to be fully submerged after a LOCA and completion of the ECC injection. The cover plate is intended to provide additional protection to debris interceptor structures from LOCA generated loads. However, the design should also provide a means for the venting of any air trapped underneath the cover.	~~A conventional suction strainer design with a flat cover plate is not planned. A disk type RWSP suction strainer is to be used.~~
1.1.1.8	The debris interceptors should be designed to withstand the inertial and hydrodynamic effects that are due to vibratory motion of a safe shutdown earthquake (SSE) following a LOCA without loss of structural integrity.	As noted in 1.1.1.6 above, the RWSP suction strainers are designed to seismic category I and quality class B standards.
1.1.1.9	Materials for debris interceptors and sump screens should be selected to avoid degradation during periods of both inactivity and operation and should have a low sensitivity to such adverse effects as stress-assisted corrosion that may be induced by chemically reactive spray during LOCA conditions.	Corrosion resistant (stainless steel) material is used for suction strainers and all inner surfaces of the RWSP.
1.1.1.10	The debris interceptor structures should include access openings to facilitate the inspection of these structures, any vortex suppressors, and the sump outlets.	RWSP hatches are provided and suction strainers are designed to allow sump inspections.
1.1.1.11	A sump screen design (i.e., size and shape) should be chosen that will avoid the loss of NPSH from debris blockage during the period that the ECCS is required to operate in order to maintain long-term cooling or maximize the time before loss of NPSH caused by debris blockage when used with an active mitigation system (see Regulatory Position 1.1.4).	~~Strainers~~ are sized appropriately to withstand debris. ~~Because the RWSP has a large floor area, strainers are free from space restrictions and associated debris blockage.~~ An active sump strainer blockage mitigation system (Regulatory Position 1.1.4) is not applicable to the US-APWR.

Insert "all design basis"

Replace with "The ECC/CS strainers"

Add "loads and minimize debris head loss to maintain NPSH in safe."

Replace with "ECC/CS"

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 5 of 17)

No.	Regulatory Position	US-APWR Design
1.1.1.12	The possibility of debris-clogging flow restrictions downstream of the sump screen should be assessed to ensure adequate long-term recirculation cooling, containment cooling, and containment pressure control capabilities. The size of the openings in the sump debris screen should be determined considering the flow restrictions of systems served by the ECCS sump. The potential for long thin slivers passing axially through the sump screen and then reorienting and clogging at any flow restriction downstream should be considered. Consideration should be given to the buildup of debris at downstream locations such as the following: containment spray nozzle openings, HPSI throttle valves, coolant channel openings in the core fuel assemblies, fuel assembly inlet debris screens, ECCS pump seals, bearings, and impeller running clearances. If it is determined that a sump screen with openings small enough to filter out particles of debris that are fine enough to cause damage to ECCS pump seals or bearings would be impractical, it is expected that modifications would be made to the ECCS pumps or ECCS pumps would be procured that can operate long-term under the probable conditions.	The ~~debris~~ strainers are made of stainless steel and could use perforated plates in a layered disc with 0.066 in hole diameter.
1.1.1.13	ECC and containment spray pump suction inlets should be designed to prevent degradation of pump performance through air ingestion and other adverse hydraulic effects (e.g., circulatory flow patterns, high intake head losses).	~~During a LOCA, the minimum depth of water in the RWSP is 4 feet. At that minimum depth, the top of each RWSP suction strainer is submerged 3.67" below the surface of the water in the RWSP. The RWSP recirculation supply is sufficient to preclude adverse hydraulic effects (e.g., vortex formation and high suction head loss).~~ A low approach velocity at the strainer surface also mitigates the risk of vortexing.
1.1.1.14	All drains from the upper regions of the containment building, as well as floor drains, should terminate in such a manner that direct streams of water, which may contain entrained debris, will not discharge downstream of the sump screen, thereby, bypassing the sump screen.	The US-APWR design of ESF structures, systems, or components (SSCs) does not include a CSS or SIS suction flow path that bypasses the ~~RWSP suction~~ strainers.

Add " , which is sized to prevent any bypass debris larger than the minimum gap in downstream components. The design-basis bypass debris is determined and used for downstream evaluations for both in-vessel and ex-vessel portions.
For in vessel evaluations, potential impacts due to bypass debris clogging is evaluated and concluded that long term cooling in maintained.
For ex-vessel evaluations, the downstream components and equipment will be procured to meet design requirements to withstand bypass debris loads."

Replace with:
"The fully submerged advanced strainer configuration prevents vortexing from occuring."

Replace with:
"ECC/CS".

Add:
", and prevents excessive head loss due to debris clogging or two-phase flow such as sump fluid flushing or deaeration.

Replaced with "applied"

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 6 of 17)

No.	Regulatory Position	US-APWR Design
1.1.1.15	Advanced strainer designs (e.g., stacked disc strainers) have demonstrated capabilities that are not provided by simple flat plate or cone-shaped strainers or screens. For example, these capabilities include built-in debris traps where debris can collect on surfaces while keeping a portion of the screen relatively free of debris. The convoluted structure of such strainer designs increases the total screen area, and these structures tend to prevent the condition sometimes referred to as the TBE. It may be desirable to include these capabilities in any new sump strainer/screen designs. The performance characteristics and effectiveness of such designs should be supported by the appropriate test data for any particular intended application.	An advanced strainer design is ~~planned~~ for the US-APWR. ~~Thin Bed Effects (TBE) are addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).~~ Add last sentence: The strainer is sized to withstand all design-basis debris loads, and prototypical strainer head loss tests were implemented to validate the design-basis debris head loss utilized for safety evaluations.
1.1.2	**Minimizing Debris** The debris (see Regulatory Position 1.3.2) that could accumulate on the sump screen should be minimized.	**Design Features and Capabilities** The design features and capabilities employed to minimize debris are presented below.
1.1.2.1	Cleanliness programs should be established to clean the containment on a regular basis, and plant procedures should be established for the control and removal of foreign materials from the containment.	Cleanliness, housekeeping, and foreign material exclusion areas are administrative controls developed by any applicant referencing the certified US-APWR design for construction and operation.
1.1.2.2	Insulation types (e.g., fibrous and calcium silicate) that are sources of debris known to readily transports to the sump screen and cause higher head losses may be replaced with insulation (e.g., reflective metallic insulation) that transports less readily and causes less severe head losses once deposited onto the sump screen. If insulation is replaced or otherwise removed during maintenance, abatement procedures should be established to avoid generating debris or its residue in the containment.	~~Particulate (e.g., Min-K based) insulation is excluded from the containment by design. Insulation is a purchased product and its use is controlled to meet the parameters provided in the US-APWR Sump Strainer Performance document (Ref. 6.2-34)~~
1.1.2.3	To minimize potential debris caused by chemical reaction of the pool water with metals in the containment, exposure of bare metal surfaces (e.g., scaffolding) to containment cooling water through spray impingement or immersion should be minimized, either by removal or by chemical-resistant protection (e.g., coatings or jackets).	The principal measures taken by the US-APWR design to preclude adverse chemical effects include the use of a buffering agent, NaTB, and minimizing the use of aluminum.

Replaced with:
"The US-APWR design maximizes the use of RMI insulation and precludes the use of problematic insulation (fiber and particulate) in the containment. The strainer is designed to allow the use of additional fiber insulation as an operational margin for future plant operation. Programmatic controls will be established by any applicant referencing certified US-APWR design to avoid generating debris during the plant maintenance and operation which may exceed the design-basis."

Add last sentence:
"Programmatic controls will be established by any applicant referencing certified US-APWR design to limit aluminum and avoid generating chemical debris during plant maintenance and operation which may exceed the design-basis."

Insert following sentence at first:
"The US-APWR does not rely on operator action to prevent the accumulation of debris on the ECC/CS strainers or to mitigate the consequences of the accumulation of debris on the ECC/CS strainers. However, Containment spray and SI pump operating ....."

Replace with "Appendix-B"

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 7 of 17)

No.	Regulatory Position	US-APWR Design
1.1.3	**Instrumentation** If relying on operator action to mitigate the consequences of the accumulation of debris on the ECC sump screens, safety-related instrumentation that provides operators with an indication and audible warning of impending loss of NPSH for ECCS pumps should be available in the MCR.	**Design Features and Capabilities** ~~containment spray and SI pump operating~~ information is available in the MCR to assist in NPSH evaluation and includes flow, suction, discharge pressure, and pump motor current.
1.1.4	**Active Sump Screen System** An active device or system (see examples in ~~Appendix 5~~) may be provided to prevent the accumulation of debris on a sump screen or to mitigate the consequences of the accumulation of debris on a sump screen. An active system should be able to prevent debris that may block restrictions found in the systems served by the ECC pumps from entering the system. The operation of the active component or system should not adversely affect the operation of other ECC components or systems. The performance characteristics of an active sump screen system should be supported by the appropriate test data that address head loss performance.	**Design Features and Capabilities** An active sump strainer blockage mitigation system is not applicable to the US-APWR.
1.1.5	**Inservice inspection** To ensure the operability and structural integrity of the trash racks and screens, access openings are necessary to permit the inspection of the ECC sump structures and outlets. Inservice inspection of racks, screens, vortex suppressors, and sump outlets, including a visual examination for evidence of structural degradation or corrosion, should be performed on a regular basis at every refueling period outage. Inspection of ECC sump components late in the outage can ensure the absence of foreign material in the ECC sump.	RWSP hatches are provided and ~~suction~~ strainers are designed to allow sump inspections. Corrosion resistant (stainless steel) material is used for suction strainers and all inner surfaces of the RWSP. Inservice inspection of strainers, structural distress and evidence of abnormal corrosion is addressed in Subsection 6.2.2.4 and Technical Specification surveillance 3.5.2.5.

Replace with "the ECC/CS".

Replaced with "1.3"

Replace with "the ECC/CS".

Replace with "ECC/CS".

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 8 of 17)

No.	Regulatory Position	US-APWR Design
1.2	**Evaluation of Alternative Water Sources** To demonstrate that a combination of the features and actions listed above is adequate to ensure long-term cooling and that the five criteria of 10 CFR 50.46(b) will be met post-LOCA, an evaluation using the guidance and assumptions in Regulatory Position ~~3.1~~ is conducted. If relying on operator action to prevent the accumulation of debris on ECC sump screens or to mitigate the consequences of the accumulation of debris on the ECC sump screens, an evaluation is performed to ensure that the operator has adequate indications, training, time, and system capabilities to perform the necessary actions. If not covered by emergency operating procedures, procedures use alternative water sources that activate when unacceptable head loss renders the sump inoperable. The valves needed to align the ECCS and CSSs (taking suction from the recirculation sumps) with an alternative water source are periodically inspected and maintained.	In US-APWR, "operator action to prevent the accumulation of debris on ~~ECC sump~~ strainers or to mitigate the consequences of the accumulation of debris on the ~~ECC sump~~ strainers" and "use of alternate water source" is not required. An active sump strainer blockage mitigation system is not applicable to the US-APWR.
1.3	**Evaluation of Long-Term Recirculation Capability** The following techniques, assumptions, and guidance is used in a deterministic, plant-specific evaluation to ensure that any implementation of a combination of the features and capabilities listed in Regulatory Position 1.1 are adequate to ensure the availability of a reliable water source for long-term recirculation following a LOCA. The assumptions and guidance listed below are also used to develop test conditions for sump screens. Evaluation and confirmation of (1) sump hydraulic performance (e.g., geometric effects, air ingestion), (2) debris effects (e.g., debris transport, interceptor blockage, head loss), and (3) the combined impact on NPSH available at the pump inlet, is performed to ensure that long-term recirculation cooling is accomplished following a LOCA. Such an evaluation arrives at a determination of NPSH margin calculated at the pump inlet. An assessment is made of the susceptibility to debris blockage of the containment drainage flowpaths to the recirculation sump (to protect against a reduction in available NPSH if substantial amounts of water are held up or diverted away from the sump). An assessment is made of the susceptibility of the flow restrictions in the ECCS and CSS recirculation flow paths downstream of the sump screens and of the recirculation pump seal and bearing assembly design to failure from particulate ingestion and abrasive effects to protect against degradation of long-term recirculation pumping capacity.	**Design Features and Capabilities** Performance of long-term recirculation is evaluated by adopting ~~NEI 04-07~~ methodology. ~~Further and additional evaluation is conducted in accordance with the US-APWR Sump Strainer Performance document (Ref. 6.2-34).~~

Replace with "the SE of NEI 04-07".

Replace with:
"Subsection 6.2.2.3.1 to 6.2.2.3.14 provides the key US-APWR plant information with respect to the assumptions and guidance listed in the regulatory position 1.3. Further detail is discussed in the US-APWR GSI-191 associated technical reports (Ref. 6.2-34, 6.2-36, 6.2-38)."

Replace with "1.3.1.2".

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 9 of 17)

No.	Regulatory Position	US-APWR Design
1.3.1.1	ECC and containment heat removal systems should be designed so that sufficient available NPSH is provided to the system pumps, assuming the maximum expected temperature of the pumped fluid and no increase in containment pressure from that present prior to the postulated LOCA. (See Regulatory Position ~~3.1.2~~, below.) For sump pools with temperatures less than 212° F, it is conservative to assume that the containment pressure equals the vapor pressure of the sump water. This ensures that credit is not taken for the containment pressurization during the transient. For sub-atmospheric containments, this guidance should apply after the injection phase has terminated. For sub-atmospheric containments, prior to the termination of the injection phase, NPSH analyses should include conservative predictions of the containment atmospheric pressure and sump water temperature as a function of time.	Post-LOCA containment pressure is not credited for US-APWR NPSH evaluation of ECC and containment heat removal systems.
1.3.1.2	For certain operating PWRs for which the design cannot be practicably altered, conformance with Regulatory Position ~~3.1.1~~ (above) may not be possible. In these cases, no additional containment pressure should be included in the determination of available NPSH than is necessary to preclude pump cavitation. The calculation of available containment pressure and sump water temperature as a function of time should underestimate the expected containment pressure and overestimated the sump water temperature when determining the available NPSH for this situation.	Not applicable to US-APWR. (This item applies to operating PWR plants only.)
1.3.1.7	The calculation of pipe and fitting resistance and the calculation of the nominal screen resistance without blockage by debris should be done in a recognized, defensible method or determined from applicable experimental data.	Hydraulic resistance of piping, fittings, and valves is calculated using an approved method using widely recognized and approved industry standards. Head loss of the suction strainer selected and the customary review of the construction configuration are addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).
1.3.1.8	Sump screen flow resistance that is due to blockage by LOCA-generated debris or foreign material in the containment that is transported to the suction intake screens should be determined using Regulatory Position ~~3.4~~.	Design analysis uses Regulatory Position ~~3.4~~.

Replace with "1.3.1.1".

Insert row No 1.3.1.3 - 1.3.1.6 from below pages.

Replace with "1.3.4."

Replace with "1.3.4."

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 10 of 17)

Replace with "SE of the NEI 04-07"

No.	Regulatory Position	US-APWR Design
1.3.1.9	Calculation of available NPSH should be performed as a function of time until it is clear that the available NPSH will not decrease further.	NPSH calculation assumptions and input values are based on limiting (most conservative) conditions that yield the smallest margin.
1.3.2	**Debris Sources and Generation**	US-APWR Design Feature
1.3.2.1	Consistent with the requirements of 10 CFR 50.46, debris generation should be calculated for a number of postulated LOCAs of different sizes, locations, and other properties sufficient to provide assurance that the most severe postulated LOCAs are calculated. The level of severity corresponding to each postulated break should be based on the potential head loss incurred across the sump screen. Some PWRs may need recirculation from the sump for licensing basis events other than LOCAs. Therefore, licensees should evaluate the licensing basis and include potential break locations in the main steam and main feedwater lines, as well in determining the most limiting conditions for sump operation.	The break properties (e.g., sizes, locations) used in the ~~NEI 04-07~~ methodology are considered for debris generation. Break properties are ~~addressed~~ in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).
1.3.1.3	For certain operating reactors for which the design cannot be practicably altered, if credit is taken for the operation of an ECCS or containment heat removal pump in cavitation, prototypical pump tests should be performed along with post-test examination of the pump to demonstrate that pump performance will not be degraded and that the pump continues to meet all the performance criteria assumed in the safety analyses. The time period in the safety analyses during which the pump may be assumed to operate while cavitating should not be longer than the time for which the performance tests demonstrate that the pump meets performance criteria.	Not applicable to US-APWR. (This item applies to operating PWR plants only.)
1.3.1.4	The decay and residual heat produced following accident initiation should be included in the determination of the water temperature. The uncertainty in the determination of the decay heat should be included in this calculation. The residual heat should be calculated with margin.	The post-LOCA temperature-time profile of the RWSP is determined by analysis that considers decay and residual heat, and includes appropriate uncertainty and margin.
1.3.1.5	The hot channel correction factor specified in (ANSI)/HI 1.1-1.5-1994 should not be used in determining the margin between the available and required NPSH for ECCS and containment heat removal system pumps.	The Hot Channel Correction Factor is not considered in the US-APWR.

Replace with:
" determined based on the most limiting break location in terms of debris generation, transport and head loss of the strainer as discussed in Subsection 6.2.2.3.1. Further detail is discussed ..."

These row No. 1.3.1.3 - 1.3.1.6 should be moved after the row No. 1.3.1.2.

These row No. 1.3.1.3 - 1.3.1.6 should be moved after the row No. 1.3.1.2.

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 11 of 17)

No.	Regulatory Position	US-APWR Design
1.3.1.6	The calculation of available NPSH should minimize the height of water above the pump suction (i.e., the level of water on the containment floor). The calculated height of water on the containment floor should not consider quantities of water that do not contribute to the sump pool (e.g., atmospheric steam, pooled water on floors and in refueling canals, spray droplets and other falling water). The amount of water in enclosed areas that cannot be readily returned to the sump should not be included in the calculated height of water on the containment floor.	Post-LOCA water level in the RWSP is conservatively estimated and does not consider the quantity of water (including "trapped" water in enclosed areas) that does not contribute to the RWSP.

Insert following sentence between "the" and "NEI-04-07" :
"ZOI(s) corresponding to debris types as recommended in SE of the ..."

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 12 of 17)

No.	Regulatory Position	US-APWR Design
1.3.2.2	An acceptable method for estimating the amount of debris generated by a postulated LOCA is to use the zone of influence (ZOI). Examples of this approach are provided in NUREG/CR-6224 and Boiling Water Reactor Owners' Group (BWROG) Utility Resolution Guidance (NEDO-32686 and the staffs Safety Evaluation on the BWROG's response to NRC Bulletin 96-03). A representation of the ZOI for commonly-used insulation materials is shown in Figure 3. The size and shape of the ZOI should be supported by analysis or experiments for the break and potential debris. The size and shape of the ZOI should be consistent with the debris source (e.g., insulation, fire barrier materials) damage pressures, (i.e., the ZOI should extend until the jet pressures decrease below the experimentally determined damage pressures appropriate for the debris source). The volume of debris contained within the ZOI should be used to estimate the amount of debris generated by a postulated break. The size distribution of debris created in the ZOI should be determined by analysis or experiments. The shock wave generated during the postulated pipe break and the subsequent jet should be the basis for estimating the amount of debris generated and the size or size distribution of the debris generated within the ZOI. Certain types of material used in a small quantity inside the containment can, with adequate justification, be demonstrated to make a marginal contribution to the debris loading for the ECC sump. If debris generation and debris transport data have not been determined experimentally for such material, it may be grouped with another, like material existing in large quantities. For example, a small quantity of fibrous filtering material may be grouped with a substantially large quantity of fibrous insulation debris, and the debris generation and transport data for the filter material need not be determined experimentally. However, such analyses are valid only if the small quantity of material treated in this manner does not have a significant effect when combined with other materials (e.g., a small quantity of calcium silicate combined with fibrous debris).	The debris generated by a postulated pipe break is estimated by applying the NEI 04-07 methodology. Debris generation is addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).

Insert following sentence between "in" and "the"":
"subsection 6.2.2.3.3. Further detail is discussed in ....."

Insert following sentence after "methodology.":
"A reduced ZOI for protective coating (Ref 6.2-51 and 6.2-52) is applied for coating debris generation."

This row No. 1.3.2.3 and 1.3.2.4 should be inserted here.

Replaced with:
"Chemical debris is considered in the design-basis debris of the US-APWR and utilized in the analyses. The US-APWR chemical effects test using plant debris source material was implemented and test data was used for quantifying the chemical debris."

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 13 of 17)

No.	Regulatory Position	US-APWR Design
1.3.2.5	The cleanliness of the containment during plant operation should be considered when estimating the amount and type of debris available to block the ECC sump screens. The potential for such material (e.g., thermal insulation other than piping insulation, ropes, fire hoses, wire ties, tape, ventilation system filters, permanent tags or stickers on plant equipment, rust flakes from unpainted steel surfaces, corrosion products, dust and dirt, latent individual fibers) to impact head loss across the ECC sump screens should also be considered.	Cleanliness, housekeeping and foreign material exclusion areas are administrative controls and programs to be developed by any applicant referencing the certified US-APWR design for construction and operation.
1.3.2.6	In addition to debris generated by jet forces from the pipe rupture, debris created by the resulting containment environment (thermal and chemical) should be considered in the analyses. Examples of this type of debris would be disbondment of coatings in the form of chips and particulates or formation of chemical debris (precipitants) caused by chemical reactions in the pool.	~~Principal measures taken by the US-APWR design to preclude adverse chemical effects include the use of the buffering agent, NaTB, and minimizing the use of aluminum.~~
1.3.2.7	Debris generation that is due to continued degradation of insulation and other debris when subjected to turbulence caused by cascading water flows from upper regions of the containment, or near the break overflow region should be considered in the analyses.	~~Break properties and debris production considerations are based on NEI 04-07 methodology and are addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).~~
1.3.2.3	A sufficient number of breaks in each high-pressure system that relies on recirculation should be considered to reasonably bound variations in debris generation by the size, quantity, and type of debris. At a minimum, the following postulated break locations should be considered. Breaks in the reactor coolant system (e.g., hot leg, cold leg, pressurizer surge line) and, depending on the plant licensing basis, main steam and main feedwater lines with the largest amount of potential debris within the postulated ZOI. Large breaks with two or more different types of debris, including the breaks with the most variety of debris, within the expected ZOI. Breaks in areas with the most direct path to the sump, medium and large breaks with the largest potential particulate debris to insulation ratio by weight. Breaks that generate an amount of fibrous debris that, after its transport to the sump screen, could form a uniform thin bed that could subsequently filter sufficient particulate debris to create a relatively high head loss referred to as the TBE. The minimum thickness of fibrous debris needed to form a thin bed has typically been estimated at 0.125 inch thick, based on the nominal insulation density (NUREG/CR-6224).	The break ~~properties (e.g., sizes, locations) used in the~~ NEI 04-07 methodology are addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).

This row No. 1.3.2.3 should be moved after the row No. 1.3.2.2

Replaced with:
" selection is performed base on the five break location criteria recommended in the SE of .....

Replaced with:
The US-APWR conservatively assumes that all debris is fine which is transported to the strainer. No debris settlement or entrapment in containment is credited in the analysis. 30 day-erosion is not applicable to the US-APWR debris generation analysis.

Insert between "methodology" and "are":
" and the most limiting break location is utilized for debris generation analysis as discussed in subsection 6.2.2.1. Further details ....."

This row No. 1.3.2.4 should be moved before the row No. 1.3.2.5

Insert following sentence between "in" and "the":
" subsection 6.2.2.3.2. Further details are discussed in ....."

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 14 of 17)

No.	Regulatory Position	US-APWR Design
1.3.2.4	All insulation (e.g., fibrous, calcium silicate, reflective metallic), painted surfaces, fire barrier materials, and fibrous, cloth, plastic, or particulate materials within the ZOI should be considered a debris source. Analytical models or experiments should be used to predict the size of the postulated debris. For breaks postulated in the vicinity of the pressure vessel, the potential for debris generation from the packing materials commonly used in the penetrations and the insulation installed on the pressure vessel should be considered. Particulate debris generated by pipe rupture jets stripping off paint or coatings and eroding concrete at the point of impact should also be considered.	Potential debris sources, types, and characteristics are addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).
1.3.3.1	The calculation of the debris quantities transported from debris sources to the sump screen should consider all modes of debris transport, including airborne debris transport, containment spray wash-down debris transport, and containment sump pool debris transport. Consideration of the containment pool debris transport should include, (1) debris transport during the fill-up phase, as well as during the recirculation phase, (2) the turbulence in the pool caused by the flow of water, water entering the pool from break overflow, and containment spray drainage, and (3) the buoyancy of the debris. Transport analyses of the debris should consider: (1) debris that would float along the pool surface, (2) debris that would remain suspended due to pool turbulence (e.g., individual fibers and fine particulates), and (3) debris that readily settles to the pool floor.	~~Debris quantity calculations consider appropriate transport modes and mechanisms for LOCA phases and conditions, consistent with NEI 04-07 guidance and recommendations. Further analysis and evaluation of phenomena affecting the RWSP performance~~ are addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).
1.3.3.2	The debris transport analyses should consider each type of insulation (e.g., fibrous, calcium silicate, reflective metallic) and debris size (e.g., particulates, fibrous fine, large pieces of fibrous insulation). The analyses should also consider the potential for further decomposition of the debris as it is transported to the sump screen.	~~Transport analysis is addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).~~
1.3.3.3	Bulk flow velocity from recirculation operations, LOCA-related hydrodynamic phenomena, and other hydrodynamic forces (e.g., local turbulence effects or pool mixing) should be considered for both debris transport and ECC sump screen velocity computations.	~~RWSP transport and suction strainer performance computations consider appropriate bulk flow velocities and other LOCA related hydrodynamic phenomena and forces.~~

Replaced with:
"The US-APWR conservatively assumes that all generated debris in containment is transported to operable sumps during accident. No debris settlement, floating, or entrapment in containment is credited in transport analysis as discussed in Subsection 6.2.3.3.5. Further details .....".

Replaced with:
"The debris transport analyses are consider each type of debris source. 30-day erosion of debris is no longer applicable to the US-APWR, as discussed in the above Regulatory Position 1.3.2.7."

Replaced with:
"Bulk flow velocity or computed fluid dynamics (CFD) simulation is not applicable for the US-APWR debris transport evaluation. The US-APWR conservatively assumes that all generated debris in containment is transported to the sump."

Replaced with:
"Not applicable to the US-APWR. The US-APWR conservatively assumes that all generated debris is transported to the sump."

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 15 of 17)

No.	Regulatory Position	US-APWR Design
1.3.3.4	An acceptable analytical approach to predict debris transport within the sump pool is to use computational fluid dynamics (CFD) simulations in combination with the experimental debris transport data. Examples of this approach are provided in NUREG/CR-6772 and NUREG/CR-6773. Alternative methods for debris transport analyses are also acceptable, provided they are supported by adequate validation of analytical techniques using experimental data to ensure that the debris transport estimates are conservative with respect to the quantities and types of debris transported to the sump screen.	~~RWSP debris transport design analysis is performed by alternate methods, uses approved analytical techniques, and is addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).~~
1.3.3.5	Curbs can be credited for removing heavier debris that has been shown analytically or experimentally to travel by sliding along the containment floor and that cannot be lifted off the floor within the calculated water velocity range.	~~RWSP debris transport design analysis is performed by alternate method, uses approved analytical techniques, and is addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).~~
1.3.3.6	If transported to the sump pool, all debris (e.g., fine fibrous, particulates) that would remain suspended due to pool turbulence should be considered to reach the sump screen.	~~RWSP debris transport design analysis is performed by alternate methods, uses approved analytical techniques, and is addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).~~
1.3.3.7	The time to switch over to sump recirculation and the operation of containment spray should be considered in the evaluation of debris transport to the sump screen.	RWSP is the reliable and sa… water following a LOCA. This… US-APWR design. (No suction "switch-over.")
1.3.3.8	In lieu of performing airborne and containment spray wash-down debris transport analyses, it could be assumed that all debris will be transported to the sump pool. In lieu of performing sump pool debris transport analyses (Regulatory Position ~~3.3.4~~ above), it could be assumed that all debris entering the sump pool or originating in the sump will be considered transported to the sump screen when estimating screen debris bed head loss. If it is credible in a plant that all drains leading to the containment sump could become completely blocked, or an inventory holdup in the containment could happen together with debris loading on the sump screen, these ~~situations~~ could pose a worse impact on the recirculation sump performance than the assumed situations mentioned above. In this case, these situations should also be assessed.	~~Debris quantity calculations consider appropriate transport modes and mechanisms for LOCA phases and conditions, consistent with NEI 04-07 guidance and recommendations, and are addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34). Multiple RWSP drain paths located around the containment and at differing heights ensure reliable water return to RWSP. Water holdup volume is accounted for in the minimum RWSP volume (607,500 gal), and suction strainers are of the latest design available. Thus, simultaneous blockages of debris interceptors and strainers are not deemed credible.~~

Replaced with:
"Curbs are not credited for reducing debris which reaches the strainer. The US-APWR conservatively assumes that all generated debris is transported to the sump."

Replaced with:
"The US-APWR conservatively assumes that all generated debris is transported to the sump."

Replaced with:
"The US-APWR assumes that all generated debris is transported to the sump. Potential choke points which could block make-up water flow to the RWSP have been evaluated. Given the multiple drain paths to the RWSP, complete blockage of all paths to the RWSP is considered to be not credible."

Replace with "1.3.3.4"

Replaced with:
"The ECC/CS strainers are designed based on conservative assumptions so that all generated debris in containment is transported to the sumps. In addition, conservative assumptions (e.g., flow rate, temperature) are considered to conservatively evaluate the strainer head loss."

Replaced with "ECC/CS"

Replaced with:
" by design. Floating or buoyant debris does not adversely affect strainer performance."

US-A

rculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 16 of 17)

No.	Regulatory Position	US-APWR Design
1.3.3.9	The effects of floating or buoyant debris on the integrity of the sump screen and on subsequent head loss should be considered. For screens that are not fully or are only shallowly submerged, floating debris could contribute to the debris bed head loss. The head loss due to floating or buoyant debris could be minimized by a design feature to keep buoyant debris from reaching the sump screen.	The four ~~RWSP suction~~ strainers are widely separated and fully submerged ~~(approx. 4 ft. at minimum) as base-mounted on the RWSP floor, and are of a low-flow design presenting approximately 3,510 ft^2 surface area.~~
1.3.4 1.3.4.1	**Debris Accumulation and Head Loss** ECC sump screen blockage should be evaluated based on the amount of debris estimated using assumptions and criteria of Regulatory Position 3.2 and on debris transported to the ECC sump (Regulatory Position 3.3.) The debris volume should be used to estimate the rate of accumulation of debris on the ECC sump screen.	~~Debris that reaches the RWSP suction strainer is considered to be clogging the strainer surface. A plant-specific strainer performance characteristics evaluation is addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).~~
1.3.4.2	Consideration of ECC sump screen submergence (full or partial) at the time of switchover to ECCS should be given in calculating the available (wetted) screen area. For plants in which containment heat removal pumps take suction from the ECC sump before switchover to the ECCS, the available NPSH for these pumps should consider the submergence of the sump screens at the time these pumps initiate suction from the ECC sump. Unless otherwise shown analytically or experimentally, debris should be assumed to be uniformly distributed over the available sump screen surface. Debris mass should be calculated based on the amount of debris estimated to reach the ECC sump screen. (See Revision 1 of NUREG-0897, NUREG/CR-3616, and NUREG/CR-6224.)	US-APWR design does not require suction "switch over." ~~An NPSH evaluation of the CSS head loss is addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).~~
1.3.4.3	For fully submerged sump screens, the NPSH available to the ECC pumps should be determined using the conditions specified in the plant's licensing basis.	~~NPSH design analysis inputs are addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34).~~
1.3.4.4	For partially submerged sumps, NPSH margin may not be the only failure criterion (see Appendix A). For partially submerged sumps, credit should only be given to the portion of the sump screen that is expected to be submerged, as a function of time. Pump failure should be assumed to occur when the head loss across the sump screen (including only the clean screen head loss and the debris bed head loss) is greater than one-half of the submerged screen height or NPSH margin.	Not applicable to US-APWR design. ~~Suction~~ strainers are submerged ~~(approx. 4 ft., minimum)~~ during a LOCA.

Replaced with:
"Strainers are fully submerged from the beginning of postulated accidents. All debris is considered to be uniformly distributed over the strainer disks surface. This has been demonstrated by testing."

Replace with "The ECC/CS"

Insert "the"

Delete "(approx 4ft, minimum)"

Replaced with:
"The ECC/CS strainers is designed based on conservative assumptions so that all generated debris in containment is transported to the sumps. In addition, conservative assumptions (e.g., flow rate, temperature) are considered to conservatively evaluate the strainer head loss. "

Table 6.2.2-2 Comparison of RWSP Recirculation Intake Debris Strainer Design to RG 1.82 Requirements (Sheet 17 of 17)

No.	Regulatory Position	US-APWR Design
1.3.4.5	Estimates of head loss caused by debris blockage should be developed from empirical data based on the sump screen design (e.g., surface area and geometry), postulated combinations of debris (i.e., amount, size distribution, type), and approach velocity. Because the debris beds that form on sump screens can trap debris that would pass through an unobstructed sump screen opening, any head loss correlation should conservatively account for filtration of particulates by the debris bed, including particulates that would pass through an unobstructed sump screen.	~~Head loss estimates are consistent with NEI 04-07 guidance and recommendations. Information on sump screen performance for long-term cooling is proposed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34)~~.
1.3.4.6	Consistent with the requirements of 10 CFR 50.46, head loss should be calculated for the debris beds formed of different combinations of fibers and particulate mixtures (e.g., minimum uniform thin bed of fibers supporting a layer of particulate debris) based on assumptions and criteria described in Regulatory Positions ~~3.2 and 3.3~~.	~~Debris accumulation and characterization is addressed in the US-APWR Sump Strainer Performance document (Ref. 6.2-34)~~.

Replace with "1.3.2 and 1.3.3"

Replaced with:
"The design basis strainer head loss includes additional margin from the empirical data obtained by the US-APWR strainer head loss tests. The tests were implemented and terminated after sufficient pool turnover to ensure all debris accumulated on the strainer surfaces. The tests demonstrated that there was no unobstructed portions of the strainer surface and recirculated particles were further filtered by the debris bed."

Replaced with:
"The design basis strainer head loss includes additional margin from the empirical data obtained by the US-APWR strainer head loss tests. The tests were designed to form a mixed bed consisting of all debris types (i.e., fiber insulation, coating particles, latent fiber and dirt/dust, and chemical debris). The tests demonstrated formation of a thin bed over the strainer surface and further filtering of recirculated particle debris."

Add new Table 6.2.2.4

Table 6.2.2-4 Design Basis Debris

Type		Amount
RMI (Transco)		106 (ft^3)
Fibrous Insulation (Nukon)		0.0 (ft^3) (1)
Coating (Epoxy)		3.0 (ft^3) (2)
Latent Debris (200 lbm)	Fiber (15%)	30 (lbm)
	Particle (85%)	170 (lbm)
Chemical debris	Aluminum Hydroxide	145 (lbm)
	Sodium Aluminum Silicate	160 (lbm)

Note: The following debris is included as operational margin, in addition to the amounts above:
(1) 1.875 (ft^3) of fiber debris
(2) 200 (lbs) of coating debris

Subsection 6.3

Emergency Core Cooling Systems

pressure of the accumulator is 700 psig. This value provides margin to the normal operating pressure (i.e., nitrogen pressure) of 640 psig.

The flow rate coefficient and uncertainty of the flow damper is described in Ref. 6.3-3 and Ref. 6.3-4.

6.3.2.2.3 Refueling Water Storage Pit

The RWSP is designed to have a sufficient inventory of boric acid water for refueling and long-term core cooling during a LOCA. A minimum of 81,230 ft^3 of available water is required in the RWSP. Sufficient submerged water level is maintained to secure the minimum NPSH for the SI pumps. The RWSP capacity includes an allowance for instrument uncertainty and the amount of holdup volume loss within the containment. The capacity of the RWSP is optimized for a LOCA in order to prevent an extraordinarily large containment. Therefore, a refueling water storage auxiliary tank containing 29,410 ft^3 is provided separately outside the containment to ensure that the required volume for refueling operations is met. Table 6.3-5 presents the relevant RWSP data. Detail description of structure and capacity of RWSP is provided in Subsection 6.2.2.2.

The temperature during normal operation is in a range of 70 to 120°F. The peak temperature following a LOCA is approximately ~~250°F~~. 270 F

The boric acid water in the RWSP is purified using the refueling water storage system (RWS). The RWS is shown in Figure 6.3-7 and may be cross-connected to one of two SFPCS filter and demineralizer vessels to remove the solid materials and the dissolved impurities for purification. The capacity of the purification subsystem is designed to maintain the chemistry of the spent fuel pool, the refueling cavity, the refueling water storage auxiliary tank, and the RWSP. Chapter 9, Subsection 9.1.3, discusses the SFPCS purification of the boric acid water.

6.3.2.2.4 ECC/CS Strainers

Four independent sets of strainers are provided inside the RWSP as part of the ECCS and CSS. ECC/CS strainers are provided for preventing debris from entering the safety systems, which are required to maintain the post-LOCA long-term cooling performance. ECC/CS strainers are designed to comply with RG 1.82. Strainer compliance with RG 1.82 is discussed in Subsection 6.2.2.2.6.

The RWSP is located at the lowest part of the containment in order to collect containment spray water and blowdown water by gravity. It is compartmentalized by a concrete structure against the upper containment area. Connecting pipes that drain the collected water from the upper containment are provided in the ceiling of the RWSP. The fully submerged strainers are installed on the bottom floor of the RWSP inside containment at elevation 3 ft. - 7 in. Below the strainers at elevation 3 ft. - 7 in. is the bottom of the RWSP sumps. Table 6.3-5 presents relevant ECC/CS strainer data.

The fully submerged strainers, in combination with the SI pump elevation, provide sufficient NPSH to ensure continuous suction availability without cavitation during all postulated events requiring the actuation of the ECCS.

The strainer sizing accommodates the estimated amount of debris potentially generated in containment. (Subsection ~~6.2.2.26~~) 6.2.2.2.6

Insert "the SE of the"

~~The Sump Strainer~~ Performance Evaluation document (Ref. 6.2-34) evaluates parameters described in NEI 04-07 (Ref. 6.2-24). Reference 6.2-36 provides additional detailed evaluation of downstream effects potentially impacting the safety functions associated with pumps, valves, heat exchangers, instrumentation (sensing lines and flow measuring devices), spray nozzles, reactor vessel flow paths. Evaluation of downstream effects is described in the report "Sump Strainer Downstream Effects" (Ref: 6.2-36).

6.3.2.2.5 NaTB Baskets and NaTB Basket Containers

Crystalline NaTB additive is stored in the containment and is used to raise the pH of the RWSP from 4.3 to at least 7.0 post-LOCA. The chemical composition of NaTB is $Na_2B_4O_7 \cdot 10\ H_2O$. (Sodium tetra-borate decahydrate is also known as "borax" and can be written $B_4O_7Na_2 \cdot 10\ H_2O$.)

The total weight of NaTB contained in the baskets is at least 44,100 pounds to raise the pH of the borated water in the containment following an accident to at least 7.0.

Twenty-three NaTB baskets are placed in the containment to maintain the desired post-accident pH conditions in the recirculation water. The buffering agent is mixed with the recirculation water in the containment so that the desired post-accident pH conditions in the recirculation water is maintained.

Twenty three NaTB baskets are divided and installed into three NaTB basket containers. Figure 6.3-8 and Figure 6.3-9 are the plan and sectional views of the NaTB baskets and NaTB basket containments installation, which are located on the maintenance platform in the containment at elevation 121 ft. - 5 in. The upper lips of the NaTB Basket Containers are approximately 1 ft. - 7 in. above the top of the NaTB baskets. This allows for the full immersion of the baskets and the optimum NaTB transfer to the RWSP.

The NaTB basket containers include the following number of NaTB baskets:

- Container A: Nine NaTB baskets
- Container B: Seven NaTB baskets
- Container C: Seven NaTB baskets

The top face of each container is open to receive spray water from the CSS nozzles during an accident and, after a period-of-time, each container is filled with spray water. As shown in Figure 6.3-9, spray ring D is located directly above the NaTB baskets at elevation 131 ft. - 6 in. Figure 6.3-10 and Figure 6.3-11 present the plan and sectional views of the spray distribution, coverage patterns, and spray trajectories for the NaTB baskets. Subsection 6.2.2 provides a discussion of the CSS.

The top face of the refueling cavity is open and blanketed by the containment spray during an accident. The spray water, which flows into the refueling cavity, is drained through the two refueling cavity drain pipes to the RWSP.

Table 6.3-2 Response of US-APWR to Unresolved Safety Issues (Sheet 2 of 2)

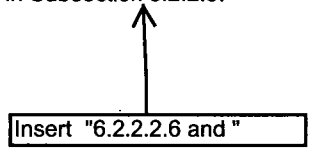
A-40	**SEISMIC DESIGN CRITERIA** Seismic design requirements and methodology have evolved. But early plants were designed without specific seismic requirements. These plants need to be reviewed based on the latest knowledge.	US-APWR is designed based on the latest seismic design criteria. (Refer to DCD Chapter 3, Section 3.7).
A-43	**CONTAINMENT EMERGENCY SUMP PERFORMANCE** After a LOCA, ECCS degradation is a concern due to air or material intrusion in the recirculation sump screen. The following specific items are: 1. Pump failure due to vortex, or air intrusion. 2. Screen clogging due to foreign materials such as collapsed insulation attributable to a LOCA and loss of pump NPSH from a clogged screen. 3. Operability problems with RHR/CSS pump due to air and foreign materials, and, effect of foreign particles to seals and bearings.	This issue is discussed in Subsection 6.2.2.3. 
B-61	**ALLOWABLE ECCS EQUIPMENT OUTAGE PERIODS** The current outage/maintenance periods for ECCS equipment are determined using engineering judgment. Unavailability of ECCS equipment is between 0.3 and 0.8 need to be optimized. In the United States, On-Line Maintenance is frequently performed and discussed using the PSA method in light of safety.	In the US-APWR, ECCS consists of four independent trains of mechanical components and electrical equipments. The US-APWR allows On-Line Maintenance without conflicting the limiting condition for operation (LCO).

Table 6.3-3 Response of US-APWR to Generic Safety Issues (Sheet 2 of 2)

No.	Regulatory Position	US-APWR Design
122.2	**INITIATING FEED AND BLEED** This issue addresses the emergency operating procedure and operator training to assess the necessity of initiation of cooling operation using feed-and-bleed based on the experienced loss-of-steam generator cooling incident at Davis Besse described in NUREG-1154.	This issue is discussed in Subsection 6.3.2.8.
185	**CONTROL OF RECRITICALITY FOLLOWING SMALL BREAK LOCA IN PWRS** In PWR plants, if RCPs and natural circulation stopped during small break LOCA, steam generated at the core could be condensed in the SG and be accumulated in the outlet plenum and crossover piping. When the natural circulation or RCP is restarted, the low concentration boric acid coolant could flow into the core and result in recriticality.	This issue was considered not to be a generic safety issue by the NRC, and closed.
191	**ASSESSMENT OF DEBRIS ACCUMULATION ON PWR SUMP PERFORMANCE(Rev.1)** Another phenomenon and failure mode that are not considered in USI, A-43, were revealed in a study concerning ECCS sump strainer blockage in BWR plants. In addition, debris such as degradation or failure of paint in the containment and associated sump blockage in PWR plants was revealed by plant operating experience. NRC recognized this matter and required the extended study to address these latest safety issues.	This issue is discussed in Subsection 6.2.2.3. Insert "6.2.2.2.6 and "

Table 6.3-4 Response of US-APWR to Generic Letters and Bulletins (Sheet 6 of 11)

No.	Regulatory Position	US-APWR Design
GL 98-04	**POTENTIAL FOR DEGRADATION OF THE EMERGENCY CORE COOLING SYSTEM AND THE CONTAINMENT SPRAY SYSTEM AFTER A LOSS-OF-COOLANT ACCIDENT BECAUSE OF CONSTRUCTION AND PROTECTIVE COATING DEFICIENCIES AND FOREIGN MATERIAL IN CONTAINMENT** NRC alerts licensees that foreign material continues to be found inside operating nuclear power plant containments. During a design basis LOCA, this foreign material could block an ECCS or safety-related CSS flow path or damage ECCS or safety-related CSS equipment. The NRC is also issuing this GL to alert the licensees to the problems associated with the material condition of Service Level 1 protective coatings inside the containment and to request information under 10 CFR 50.54(f) to evaluate the licensees' programs for ensuring that Service Level 1 protective coatings inside containment do not detach from their substrate during a design basis LOCA and interfere with the operation of the ECCS and the safety related CSS. As a result of NRC findings in these areas and due to the importance of ensuring system functionality, within 120 days of the date of this GL, licensees are required to submit a written response ensuring that Service Level 1 protective coatings inside containment do not detach from their substrate during a design basis LOCA.	This issue is discussed in Subsection ~~6.2.2.3.~~ Replace with " 6.1.2, 6.2.2.3.2, and 6.2.2.3.9. "
BL 80-01	**OPERABILITY OF ADS VALVE PNEUMATIC SUPPLY** With respect to the reliability problem of ADS pneumatic supply (either nitrogen or air) system identified in Peach Bottom 2 and 3, the NRC requested each BWR utility to determine and report if hard-seat check valves have been installed to isolate accumulator systems, if periodic leak tests have been performed, and the seismic qualifications of the ADS pneumatic supply system.	N/A ADS is not installed in the US-APWR design.

Table 6.3-4 Response of US-APWR to Generic Letters and Bulletins (Sheet 8 of 11)

No.	Regulatory Position	US-APWR Design
BL 93-02	**DEBRIS PLUGGING OF EMERGENCY CORE COOLING SUCTION STRAINERS** In Perry Nuclear Plant, a BWR-6, the debris consisted of glass fibers from temporary filters that had been inadvertently dropped into the suppression pool, and corrosion products that had been filtered from the pool by the glass fibers adhering to the surface of the ECCS strainer. This caused unexpectedly rapid loss of available NPSH. NRC requested all holders of an operating license for nuclear power reactors (both PWR and BWR) to: • Identify fibrous air filters or other temporary source of fibrous material, not designed to withstand a LOCA, which are installed or stored in primary containment. • Take prompt action to remove any such material and ensure to perform ECCS functions.	This issue is discussed in DCD Chapter 6, Subsection 6.2.2.3. Insert "6.2.2.2.6 and "
BL 95-02	**UNEXPECTED CLOGGING OF A RESIDUAL HEAT REMOVAL (RHR) PUMP STRAINER WHILE OPERATING IN SUPPRESSION POOL COOLING MODE** In Limerick unit 1 which was being operated at 100% power, one safety relief valve was open. Cavitation was caused in the RHR pump which was operating to remove heat from suppression pool that received the fluid discharged from safety relief valve due to the fluctuation of motor current and flow rate. NRC requested the utility to review the operability of components such as ECCS and other pumps which draw suction from the suppression pool. In this bulletin, the NRC requested all holders of BWR operating licenses to take the following actions: • Review the operability of components such as ECCS and other pumps which draw suction from the suppression pool. The evaluation should be based on suppression pool cleanliness, suction strainer cleanliness, and the effectiveness of their foreign material exclusion practices. • The operability evaluation in the requested action above should be confirmed through appropriate test(s) and strainer inspection(s) within 120 days of the date of this bulletin. • In addition, addressees are requested to implement appropriate procedural modifications and other actions (e.g., suppression pool cleaning), as necessary, to minimize foreign material in the suppression pool, drywell and containment. Addressees are requested to verify their operability evaluation through appropriate testing and inspection.	This issue is discussed in Subsection 6.2.2.3. Insert "6.2.2.2.6 and "

Table 6.3-4 Response of US-APWR to Generic Letters and Bulletins (Sheet 9 of 11)

No.	Regulatory Position	US-APWR Design
BL 96-03	**POTENTIAL PLUGGING OF EMERGENCY CORE COOLING SUCTION STRAINERS BY DEBRIS IN BOILING-WATER REACTORS** NRC requested all BWR licensees to implement appropriate procedural measures and plant modifications to minimize the potential for clogging of ECCS suppression pool suction strainers by debris (e.g., insulations, corrosion products, other particulates (paint chips, and concrete dusts)) generated during a LOCA. All licensees are requested to implement these actions by the end of the first refueling outage starting after January 1, 1997.	This issue is discussed in Subsection 6.2.2.3. Insert "6.2.2.2.6 and "
BL 01-01	**CIRCUMFERENTIAL CRACKING OF REACTOR PRESSURE VESSEL HEAD PNENETRATION NOZZLE** In the light of the axial cracking discovered at the reactor pressure vessel head penetration nozzle in Oconee Nuclear Station Unit 1 (PWR), NRC requested all holders of operating licenses for PWR to provide the requested information.	N/A RV head does not have penetration for safety injection in the US-APWR.
BL 02-01	**REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY** This bulletin supplemented the BL-2001-01 and recommended that, for inspection of reactor pressure vessel head penetration , visual examinations should be provided with supplemental examination (by surface or volumetric examination). The NRC also requested all PWR licensees to provide information related to the inspection programs to ensure compliance with applicable regulatory requirements.	N/A RV head does not have penetration for safety injection in the US-APWR.

Table 6.3-4 Response of US-APWR to Generic Letters and Bulletins (Sheet 10 of 11)

No.	Regulatory Position	US-APWR Design
GL2004-02	**POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS** NRC requested all PWR licensee to perform a mechanistic evaluation of the potential for the adverse effects of post-accident debris blockage and operation with debris-laden fluids to impede or prevent the recirculation functions of the ECCS and CSS following all postulated accidents for which the recirculation of these systems is required, using an NRC-approved methodology. Individual addressees may also use alternative methodologies to those already approved by the NRC; however, additional staff review may be required to assess the adequacy of such approaches. Implement any plant modifications that the above evaluation identifies as being necessary to ensure system functionality.	Insert "." (period) This issue is discussed in Subsection 6.2.2.2.6, 6.2.2.3~~, and following technical reports:~~ ~~MUAP-08001 "US-APWR Sump Strainer Performance"~~ ~~MUAP-08013 "US-APWR Sump Strainer Downstream Effects"~~ Delete Technical Reports (2)
GL 2008-01	**MANAGING GAS ACCUMULATION IN EMERGENCY CORE COOLING, DECAY HEAT REMOVAL, AND CONTAINMENT SPRAY SYSTEM** The U.S. Nuclear Regulatory Commission (NRC) is issuing this generic letter (GL) to address the issue of gas accumulation in the emergency core cooling, decay heat removal (DHR), and containment spray systems for following purposes: (1) to request addressees to submit information to demonstrate that the subject systems are in compliance with the current licensing and design bases and applicable regulatory requirements, and that suitable design, operational, and testing control measures are in place for maintaining this compliance (2)to collect the requested information to determine if additional regulatory action is required	In the US-APWR, the following design provisions are provided in order to prevent void forming in the system: - To reduce gas intrusion into the safety-related pump system, fully submerged strainers are installed to function as a vortex suppressor. - To mitigate any possible gas buildup in the RCS, a temperature instrument is installed on the line from the Engineered Safety Feature to the RCS for detection in the MCR. - To prevent boric acid water containing dissolved nitrogen from flowing back from the accumulator tank to RHRS, RHRS return line and accumulator injection line are segregated. - Pump test line is provided in order to allow the dynamic venting of the system through the periodic pump full-flow testing.

Insert "." (period)

Table 6.3-4 Response of US-APWR to Generic Letters and Bulletins (Sheet 11 of 11)

No.	Regulatory Position	US-APWR Design
BL2003-01	**POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY SUMP RECIRCULATION AT PRESSURIZED-WATER REACTORS** NRC requested all PWR licensee to provide a response to state that the ECCS and CSS recirculation functions have been analyzed with respect to the potentially adverse post-accident debris blockage effects identified in this bulletin, taking into account the recent research findings described in the Discussion section, and are in compliance with all existing applicable regulatory requirements. Applicable Regulatory Guidance was Draft	Compliance with R.G 1.82 Rev.3 is discussed in Table 6.2.2-2~~, and following technical reports:~~ MUAP-08001 "US-APWR Sump Strainer Performance" MUAP-08013 "US-APWR Sump Strainer Downstream Effects"

Delete Technical Reports (2)

Table 6.3-5 Safety Injection System Design Parameters (Sheet 1 of 3)

Description	Specification
ECC/CS Strainer	
Type	Disk layer type
Number	4 sets
Surface Area	~~3,510~~ 2,754 ft^2 per train
Material	Stainless Steel
Design Flow	5,200 gpm per train
Hole diameter of perforated plate	0.066 inch
Debris Head Loss	~~4.7~~ 4.0 ft of water at ~~70~~ 120°F
Equipment Class	2
Seismic Category	I
Safety Injection Pump	
Type	Horizontal multi-stage centrifugal pump
Number	4
Power Requirement	970 kW
Design Flow	1,540 gpm
Design Head	1,640 ft.
Minimum Flow	265 gpm
Design Pressure	2,135 psig
Design Temperature	300°F
Maximum Operating Temperature	Approximately 250°F
Fluid	Boric Acid Water
NPSH Available	~~21.9 ft. at 1,540 gpm~~ 24.9 ft. Note 3
NPSH Required	~~15.7~~ 18.8 ft.
Material of Construction	Stainless Steel
Equipment Class	2
Seismic Category	I
Accumulator	
Type	Vertical Cylindrical Tank
Number	4
Capacity	3,180 ft^3 each
Design Pressure	700 psig
Design Temperature	300°F
Normal Operating Pressure	Approximately 640 psig
Normal Operating Temperature	70 ~ 120°F

Insert "Design basis"

Table 6.3-5 Safety Injection System Design Parameters (Sheet 2 of 3)

Description	Specification
Accumulator Safety Valve	1,500 ft^3/min (N_2) at 700 psig
Accumulator N_2 Supply Line Safety Valve Capacity	1,500 ft^3/min (N_2) at 700 psig
Fluid	Boric Acid Water (Approximately 4,000 ppm)
Material of Construction	Carbon steel vessel with stainless steel cladding
Auxiliaries	Flow Damper
Water Volume	≥2,126 ft^3 Note 1
Large Flow Injection Volume	≥1,326.8 ft^3 Note 2
Equipment Class	2
Seismic Category	I
Accumulator Injection Line Resistance	
Piping and Valves Equivalent Length (L/D)	≥ 461.7 ≤ 564.3
Orifice and Pipe Exit Resistance Coefficient	≥ 1.99 ≤ 2.21
NaTB Basket	
Type	Rectangular
Number	23
Total Buffering Agent Quantity (minimum)	44,100 pounds
Design Pressure	Atmosphere
Design Temperature	300°F
Normal Operating Temperature	70 ~120°F
Buffering Agent	Sodium Tetraborate Decahydrate
Material of Construction	Stainless Steel
Equipment Class	2
Seismic Category	I

Note:

1. This volume does not include dead volume.
2. Nominal value is 1,342 ft^3 .

Add "3. Detail of NPSH available is described in Reference 6-34."

Table 6.3-5 Safety Injection System Design Parameters (Sheet 3 of 3)

Description	Specification
NaTB Basket Container	
Type	Semi-rectangular
Number	3
Capacity	A:1155ft^3, B:925ft^3, C:925ft^3
Design Pressure	Atmosphere
Design Temperature	300°F
Normal Operating Temperature	70 ~120°F
Fluid	Boric Acid Water
Material of Construction	Stainless Steel
Design Code	ASME Section III, Class 2
Equipment Class	2
Seismic Category	I
Refueling Water Storage Pit	
Type	Pit Type
Number	1
Capacity	81,230 ft^3
Design Pressure	Atmosphere Note 1
Design Temperature	~~300~~ 270°F
Temperature during normal operation	70 ~ 120°F
Peak Temperature following LOCA	Approximately ~~250~~ 256 °F
Fluid	Boric Acid Water
Material of Construction	Stainless Steel
Equipment Class	2
Seismic Category	I

Note:

1. For structural design, an outside pressure occurring in accident 9.6 psi is reflected.

Tier-2

Chapter 14

14.3 Inspection, Tests, Analysis, and Acceptance Criteria

Table 14.3-1a Design Basis Accident Analysis Key Design Features (Sheet 1 of 8)

Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
1.2.5	US-APWR rated reactor core thermal power is 4451 MWt.	1.1.4 Table 4.4-1 Table 6.2.1-4 Table 15.0-2 Table 15.6.5-1 Ch. 16, TS 1.1
Table 2.3-2 ITAAC #1.a Each ASME ITAAC in 2.4.1, 2.4.2 2.4.4, 2.4.5 2.4.6	RCPB components are designed and fabricated in accordance with 10 CFR 50.55a which requires compliance with the requirements for Class 1 components in the American Society of Mechanical Engineers (ASME) Code.	5.2 6.3 9.3.4
2.2.1.2 Table 2.2-4 ITAAC #3, #5 Table 2.11.1-1 Table 2.11.1-2 ITAAC #1	The PCCV is a prestressed concrete structure designed to endure the peak pressure and temperature for LOCA, and steamline and feedline break conditions.	3.8.1.3 Table 3.8.1-1 6.2.1.1 Table 6.2.1-2
Table 2.2-1 Table 2.2-4 ITAAC #3, #5 2.11.1.1 Table 2.11.1-2 ITAAC #1	The PCCV is designed and constructed in accordance with ASME Code, Section III, and the PCCV is classified as seismic Category I structure.	3.8.1.2 6.2.7
2.2.1.2 Table 2.11.1-2 ITAAC #3	The liner plate is not designed or analyzed as a strength structural element. The minimum concrete design compressive strength (f'c) for the PCCV is 6000 psi. The minimum concrete design compressive strength (f'c) for the basemat is 4000 psi. The ultimate capacity for the PCCV is estimated based on cumulative yield strength of steel materials such as rebars, tendons, and liner plate.	3.8.1.1.1 Table 6.2.1-2 19.2.4.1
Figure 2.11.1-1 Table 2.11.1-2 ITAAC #3	The inner height of the containment is approximately 226.5 ft and the inside diameter of the containment cylinder measures approximately 149 ft. The containment dome is 3 ft.-8 in. or 4 ft.-4 in. thick, while the containment wall thickness is 4 ft.-4 in. The inner surface of containment includes a 0.25 in. welded steel plate liner anchored to the concrete.	6.2.1.1.2

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1a Design Basis Accident Analysis Key Design Features (Sheet 2 of 8)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
Table 2.2-4 ITAAC #3,#5 Table 2.11.1-1 Table 2.11.1-2 ITAAC #3	The containment design pressure is 68 psig. The PCCV is designed for an external pressure of 3.9 psig based on conservative analysis of inadvertent CSS operation. The containment design temperature is 300°F. Free volume of containment is 2,800,000 ft^3.	Table 3.8.1-1 6.2.1.5.3 Table 6.2.1-2 Table 6.5-5 15.4.8.4 15.6.5
2.4.1 Table 2.4.1-2 ITAAC #4.b	Ferritic reactor coolant pressure boundary materials meet 10 CFR 50 Appendix G fracture toughness criteria and requirements for testing.	5.2.3.3 5.3.1
2.4.2.1 Table 2.4.2-5 ITAAC #10.a	The pressurizer safety valves provide overpressure protection in accordance with the ASME Code Section III. This overpressure protection is provided for the followingbounding events • Loss of external electrical load. • Loss of normal feedwater flow. • Reactor coolant pump shaft break. • Uncontrolled rod cluster control assembly bank withdrawal from a subcritical or low-power startup condition. • Spectrum of rod ejection accidents. The sum of the capacities of the pressurizer safety valves exceeds 1.728×10^6 lb/hr (432,000 lb/hr per valve).	5.2.2.1 Table 5.2.2-1 Replaced with "6.2.2.2.6 and 6.2.3"
Table 2.4.2-5 ITAAC #10.a	Pressurizer safety valves set pressure; ≥2435 psig and ≤2485 psig	Table 5.2.2-1
Table 2.4.2-5 ITAAC #10.d	The reactor coolant flow rate per loop with 10% steam generator tube plugging is at least 112,000 gallons per minute.	Table 5.1-3
Table 2.4.2-5 ITAAC #10.c	RCPs have a rotating inertia to provide coastdown flow.	5.4.1 15.3.1.1 15.6.5.2
Table 2.4.4-5 ITAAC #7.b	The four independent ECC/CS suction strainers are designed to maintain adequate NPSH and minimize downstream effects to support ECC/CS functions, maintaining the reactor core in a long-term coolable geometry and supporting decay heat removal following a design basis accident.	~~6.2.2.2~~ Table 6.2.2-2 Table 19.1-119
Table 2.4.4-5 ITAAC #1.a	The RWSP and ECC/CS suction strainers are located at the lower elevation in containment. The coolant and associated debris from a pipe or component rupture (LOCA), and the containment spray drain into the RWSP through transfer pipes.	6.2.2.2.5 Table 19.1-119
Table 2.4.4-5 ITAAC #7.b	Insulation and coatings inside containment are consistent with the design basis evaluations of ECC/CS suction strainer performance.	6.1.2 6.1.3 6.2.2.3 Table 19.1-119

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1a Design Basis Accident Analysis Key Design Features (Sheet 3 of 8)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.4.4.1 Table 2.4.4-2 Table 2.4.4-5 ITAAC #1.a, #1.b, #6.b, #6.c, #10.b	The high head safety injection system consists of four independent and dedicated SI pump trains. The SI pump trains are automatically initiated by an ECCS actuation signal, and supply borated water from the RWSP to the reactor vessel via direct vessel injection line.	6.3.2.1 Table 19.1-119
Table 2.4.4-5 ITAAC #7.b	Each safety injection pump has a pump differential head of no less than 3937 ft and no more 4527 ft at the minimum flow, and injects no less than 1259 gpm and no more than 1462 gpm of RWSP water into the reactor vessel at atmospheric pressure.	Table 6.2.1-5 6.3 Figure 6.3-4 Figure 6.3-15 Figure 6.3-16
2.4.4.1 Table 2.4.4-5 ITAAC #7.b	Four (4) ECCS accumulators store borated water under pressure and automatically inject it into the RCS if the reactor coolant pressure decreases below the accumulator pressure. The volume of each accumulator is at least 3,180 ft^3, considering the total water volume and adding the volume of gas space and dead water volume.	Table 6.2.1-4 Table 6.2.1-5 6.3.2.2.2 Table 6.3-5
Table 2.4.4-5 ITAAC #7.b Table 2.4.4-6	The water volume injected from each accumulator into reactor vessel is ≥2126 ft^3. The water volume injected from each accumulator into reactor vessel during large flow is ≥1326.8 ft^3. The calculated resistance coefficient of the accumulator system (based on a cross-section area of 0.6827 ft^2) meets the requirements shown in Tier 1 Table 2.4.4-6. The accumulators provide the integrated function of low head injection in the event of a LOCA.	6.3 Table 6.3-5 Table 19.1-119
2.4.4.1 Table 2.4.4-5 ITAAC #7.b	The RWSP is the source of borated water for emergency core cooing and containment spray systems. The volume of the RWSP is at least 81,230 ft^3, taking into account ineffective pit volume and containment cavities and pits where water may be trapped and not drain to the RWSP.	6.2.2.2.5 Table 6.2.1-3 Table 6.2.1-4 Figure 6.2.2-7 6.3 Table 6.3-5
2.4.5.1 Table 2.4.5-5 ITAAC #8.a	RHRS provides long term core cooling.	5.4.7.1 Table 19.1-119
2.4.5.1 Table 2.4.5-5 ITAAC #1.a, #6.b, #6.c 2.11.3.1 Table 2.11.3-5 ITAAC #1.a, #6.b, #6.c	The CSS/RHRS consists of four independent subsystems, each of which receives electrical power from one of four safety buses. Each subsystem includes one CS/RHR pump and one CS/RHR heat exchanger, which have functions in both the CS system and the RHRS.	6.2.2 5.4.7.2.1 Table 19.1-119

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1a Design Basis Accident Analysis Key Design Features (Sheet 4 of 8)

Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
2.4.5.1 Table 2.4.5-5 ITAAC #1.a, #8.a 2.11.3.1 Table 2.11.3-5 ITAAC #1.a, #7.b	CSS/RHR provide long term containment and core cooling capability.	6.2.2 6.2.5 Table 19.1-119
Table 2.4.5-5 ITAAC #8.e	The CS/RHR relief valves open at a pressure not greater than the set pressure required to provide low temperature overpressure protection for the RCS, as determined by the LTOP system.	5.4.7.1
Table 2.4.5-5 ITAAC #8.a	Each CS/RHR pump is sized to deliver 3,000 gpm at a discharge head of 410 ft, and provides at least 2645 gpm to the RCS when the RCS is at atmospheric pressure.	5.4.7 Table 5.4.7-2 Figure 5.4.7-4 6.2.2 Table 6.2.1.5
Table 2.4.5-5 ITAAC #8.a	The product of the overall heat transfer coefficient and the effective heat transfer area, UA, of each as-built CS/RHR heat exchanger is greater than or equal to 1.852×10^6 Btu/hr-°F.	5.4.7 Table 5.4.7-2 6.2.2 Table 6.2.1-5
2.4.6.1 Table 2.4.6-5 ITAAC #1, #8.a	The CVCS charging pumps are arranged in parallel with common suction and discharge headers. Each pump provides full capability for normal makeup. One charging pump is capable of maintaining normal RCS inventory with small system leak if the leakage rate is less than that from a break of a pipe 3/8 inch in inside diameter.	9.3.4.2 Table 19.1-119
2.4.6.1 Table 2.4.6-5 ITAAC #1, #8.a, #8.c	The CVCS charging pumps can take suction from the VCT, the reactor makeup control system, the refueling water storage auxiliary tank and the spent fuel pit. Normally, one charging pump is operating and takes suction from the VCT, supplies charging flow to the RCS and seal water to the reactor coolant pumps.	9.3.4.2 Table 19.1-119
Table 2.4.6-5 ITAAC #8.a	Each CVCS charging pump provides a flow rate of greater than or equal to 160 gpm.	9.3.4 Table 9.3.4-2
2.5.1.1 Table 2.5.1-6 ITAAC #14.a	The PSMS initiates automatic reactor trips and ESF actuations, when the plant process signals reach a predetermined limit. (Table 2.5.1-2 and 2.5.1-3)	7.2 7.3 Table 7.2-3 Table 7.3-4

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1a Design Basis Accident Analysis Key Design Features (Sheet 5 of 8)

Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
2.5.1.1 Table 2.5.1-6 ITAAC #1	Reactor trip signal is provided by the reactor protection system (RPS), which consists of four redundant and independent trains. Four redundant measurements using sensors from the four separate trains are made for each variable used for reactor trip.	7.2.1 Table 19.1-119
2.5.1 Table 2.5.1-6 ITAAC #2	There are four redundant engineered safety function (ESF) trains.	7.3.1.8 Table 19.1-119
2.5.1 Table 2.5.1-6 ITAAC #29	ESF systems are automatically initiated from signals that originate in the RPS. Manual actuation of ESF systems is carried out through a diverse signal path that bypasses the RPS.	7.3.1.9 Table 19.1-119
2.5.1 Table 2.5.1-6 ITAAC #17.b	A single channel or division of the PSMS can be bypassed to allow on-line testing, maintenance or repair without impeding the safety function.	7.2.1 Table 19.1-119
2.5.4.1 Table 2.5.4-2 ITAAC #1, #2, #4	The PSMS and PCMS provide plant operators with information systems important to safety for: (1) assessing plant conditions and safety system performance, and making decisions related to plant responses to AOOs; and (2) preplanned manual operator actions related to accident mitigation.	7.5
2.5.4 Table 2.5.4-2 ITAAC #1, #3	For the monitoring of the post-accident inadequate core cooling, degree of subcooling, RV water level and core exit temperature will be measured.	4.4.6.4 7.5 7.5.1.1.3
2.9 Table 2.9-1 ITAAC #7 Each MCR/RSC ITAAC in applicable Tier 1 system sections	The minimum inventory of HSIs are · Fixed position continuously visible HSI · Class 1E HSI for control of all safety-related components and monitoring of all safety-related plant instrumentation is provided on the safety VDUs, located on the MCR operator console and the remote shutdown console (Section 7.1). · Minimum inventory for degraded HSI conditions	7.1 18.7.3.2 Table 18.7-1

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1a Design Basis Accident Analysis Key Design Features (Sheet 6 of 8)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.5.1.1 Table 2.5.1-6 ITAAC #4 Table 2.5.4-1 Table 2.5.4-2 ITAAC #1 2.9 Table 2.9-1 ITAAC #7	The fixed position continuously visible HSI are provided by: The fixed area of the LDP provides indications and alarms which include : · Bypassed and inoperable status indication (BISI) parameters · Type A and B post monitoring (PAM) variables (Section 7.5, Table 7.5-3) · Safety parameter displays including status of critical safety functions and performance of credited safety systems and preferred non safety systems · Prompting alarms for credited manual operator actions and risk important HAs identified in the HRA PAM displays for Type A and B variables on the safety VDUs (Subsection 7.5.1.1) Conventional switches on the MCR operator console for system level actuation of safety functions such as reactor trip, engineering safety features actuation system (ESFAS) actuation, etc. (Tables 7.2-6 and 7.3-5)	Table 7.1-1 Table 7.2-6 Table 7.3-5 7.5 Table 7.5-3 18.7.3.2
2.6.4.1 Table 2.6.4-1 ITAAC #13	The Class 1E emergency power sources (EPSs) are able to provide power at set voltage and frequency to the Class 1E 6.9kV buses within 100 seconds from the start signal.	8.3.1.1.3 Table 19.1-119
2.6.4.1 Table 2.6.4-1 ITAAC #1, #2, #13, #15.a	Each of the four divisions of the Class 1E power distribution systems is provided by a Class 1E gas turbine generator (GTG) to supply power to its dedicated safety bus as a counter measure against loss of offsite power. When loss of offsite power occurs, GTGs automatically start and would accept load in less than or equal to 100 seconds after receiving the start signal.	8.1.3.1 8.3.1.1.3
2.7.1.2.1 Table 2.7.1.2-5 ITAAC #13.a	Six main steam safety valves (MSSVs) are provided per main steam line. MSSVs with sufficient rated capacity are provided to prevent the steam pressure from exceeding 110 percent of the MSS design pressure. The sum of the rated capacities of the MSSVs exceeds 21,210,000 (lb/hr) for all 24 valves.	10.3.2.3.2
Table 2.7.1.2-5 ITAAC #13.b	The flow restrictor within the SG main steam line discharge nozzle does not exceed 1.4 sq. ft.	15.1.5.2
2.7.1.2.1 Table 2.7.1.2-5 ITAAC #14	The valves close within the following times after receipt of an actuation signal. The main steam isolation valves (MSIVs) close within 5 seconds to limit uncontrolled steam release from one SG in the event of steam line break. The main steam bypass isolation valves close within 5 seconds.	6.2.1.4.1 10.3.2.3.4

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1a Design Basis Accident Analysis Key Design Features (Sheet 7 of 8)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.7.1.2 Table 2.7.1.2-5 ITAAC #1.a	MSIVs are installed in each of the main steam lines to (1) limit uncontrolled steam release from one steam generator in the event of a steam line break, and to (2) isolate the faulted SG in the event of SGTR.	6.2.1 10.3 Table 19.1-119
2.7.1.9.1 Table 2.7.1.9-5 ITAAC #8.c	The main feedwater isolation valves (MFIVs), MFRVs, MFBRVs, SGWFCVs close within 5 seconds after receipt of an actuation signal, to limit the mass and energy release to containment consistent with the containment analysis.	6.2.1.4.1 10.4.7.2.2
2.7.1.11 Table 2.7.1.11-5 ITAAC #1.a	EFWS consists of two motor-driven pumps and two steam turbine-driven pumps with two emergency feedwater pits.	10.4.9.2 Table 19.1-119
2.7.1.11 Table 2.7.1.11-5 ITAAC #8.b	Upon detection of a water level increase of the SG, the EFW isolation valves and EFW control valves are automatically closed.	10.4.9.2 Table 19.1-119
2.7.1.11 Table 2.7.1.11-5 ITAAC #8.b	The motor-operated EFW isolation valves and EFW control valves are provided in each EFW pump discharge line to close automatically to terminate the flow to the affected (faulted) SG.	10.4.9.2 Table 19.1-119
2.7.1.11 Table 2.7.1.11-5 ITAAC #1.a	The common suction line from each EFW pit is connected by a tie line with two normally closed manual valves. When the two EFW pumps taking suction from the same pit are not available (OLM of one EFW pump and the single failure of other EFW pump), the tie line connections to EFW pits need to be established.	10.4.9.2 Table 19.1-119
Table 2.7.1.11-5 ITAAC #12	Two of the EFW pumps deliver at least 705 gpm to the any of two SGs against a SG pressure up to the set pressure of the first stage of main steam safety valve plus 3 percent.	10.4.9.2.1 Table 10.4.9-2
Table 2.7.1.11-5 ITAAC #13	The usable volume of each EFW pit is greater than or equal to 204,850 gallons.	10.4.9.3
2.7.3.1 Table 2.7.3.1-5 ITAAC #1.a	The ESWS is arranged into four independent trains (A, B, C, and D). Each train consists of one ESWP, two 100% strainers in the pump discharge line, one 100% strainer upstream of the CCW HX, one CCW HX, one essential chiller unit, and associated piping, valves, instrumentation and controls.	9.2.1.2.1 Table 19.1-119
2.7.3.3 Table 2.7.3.3-5 ITAAC #1.a	The CCWS consists of two independent subsystems. One subsystem consists of trains A & B, and the other subsystem consists of trains C & D, for a total of four trains.	9.2.2.2 Table 19.1-119
2.7.3.3 Table 2.7.3.3-5 ITAAC #7	The CCWS is designed to withstand leakage in one train without loss of the system's safety function.	9.2.2.1.1 Table 19.1-119

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1a Design Basis Accident Analysis Key Design Features (Sheet 8 of 8)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.7.3.3 Table 2.7.3.3-5 ITAAC #8.b	Two motor operated valves are located at the CCW outlet of the RCP thermal barrier Hx and close automatically upon a high flow rate signal at the outlet of this line in the event of in-leakage from the RCS through the thermal barrier Hx, and prevents this in-leakage from further contaminating the CCWS.	9.2.2.2.1.5 Table 19.1-119
2.7.5.3.1.2	The containment fan cooler system is designed to maintain containment air temperature below 120°F during the normal operation of the plant. 120°F is used as the maximum containment temperature initial condition in the safety analyses.	6.2.1.1.3.5 Table 6.2.1-4 6.3.2.1 Ch. 16 TS 3.6.5
2.7.6.2.1 Table 2.7.6.2-1 ITAAC #2	To preclude unanticipated drainage, the spent fuel pit is not connected to the equipment drain system. A weir and gate provide physical isolation of the refueling canal from each of the pits. All the gates are located above the top elevation of the fuel seated in the SFP racks: they are normally closed and only opened as required.	9.1.2.2.2
Figure 2.11.2-1 Table 2.11.2-1 Table 2.11.2-2 ITAAC #1	Containment penetration isolation features are configured as in Table 6.2.4-3 and figure 6.2.4-1.	6.2.4 Table 6.2.4-1 Table 6.2.4-3 Figure 6.2.4-1 6.2.6
2.11.3.1 Table 2.11.3-5 ITAAC #1.a, #7.b	The CSS is designed to remove containment heat, and remove fission products following an accident.	6.2.2 6.5.2 15.6.5 19.1.3.1 19.1.3.2 Table 19.1-119 19.2.3.3.3
Table 2.11.3-5 ITAAC #7.b	Two CS/RHR pumps deliver no less than 5290 gpm of RWSP water into the containment.	6.2.1 Table 6.2.1-5

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1d PRA and Severe Accident Analysis Key Design Features (Sheet 1 of 6)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.2.3.3 Table 2.2-4 ITAAC #24	SSCs that require evaluation in the seismic fragilities task of a seismic margin analysis have sufficient seismic margin.	19.1.5.1.1 Table 19.1-54 Table 19.1-119
2.4.1 Table 2.4.1-2 ITAAC #3	No penetrations through the RV are located below the top of the reactor core. This minimizes the potential for a loss of coolant accident by leakage from the reactor vessel, allowing the reactor core to be uncovered.	5.3.3.1 Table 19.1-119
2.4.2.1 Table 2.4.2-2 Figure 2.4.2-2 Table 2.4.2-5 ITAAC #2, #11.a	The reactor vessel head vent valves; the safety depressurization valve (SDV) and depressurization valves (DV) could be used for high point vents to support prevention of beyond design basis events and severe accident mitigation.	5.4.12 Table 5.4.12-3 19.1.3.1 19.1.3.2 19.2.3.3 Table 19.1-1 Table 19.1-119
2.4.2 Table 2.4.2-5 ITAAC #2, #11.a	Safety depressurization valves (SDVs) are provided at top head of the pressurizer in order to cool the reactor core by feed and bleed operation when loss of heat removal from steam generator occurs.	5.4.12.2 Table 19.1-119
2.4.2 Table 2.4.2-5 ITAAC #2, #11.a 2.4.4 Table 2.4.4-5 ITAAC #1.a, #10.a	In the event of delay in establishing RHR cooling after safety injection, the SDV and SI pump ensure long term heat removal.	Table 19.1-119
2.4.2 Table 2.4.2-5 ITAAC #2, #11.a	RCS depressurization system dedicated for severe accident is provided to prevent high pressure melt ejection.	5.4.12.2 Table 19.1-119
2.4.4 Table 2.4.4-5 ITAAC #1.a, #10.a	In the event of loss of heat removal by the RHRS and SGs, a SI pump can be manually started to maintain RCS water level.	Table 19.1-119
2.4.4 Table 2.4.4-5 ITAAC #1.a, #8	RWSP suction isolation valves can be closed to prevent leakage of RWSP water from SI, CS/RHR or RWS.	Table 19.1-119
2.4.5 Table 2.4.5-5 ITAAC #9, #11	In the case of failure of running RHRS, with RHR flow rate – low the valves on the standby RHR suction line and discharge line can be opened and the standby RHR pump started in order to maintain RHR operation.	Table 19.1-119
2.4.5.1 Table 2.4.5-5 ITAAC #1.a	Alternate core cooling/injection utilizing CSS/RHRS is available in case all safety injection fails.	Table 19.1-1 Table 19.1-119 19.2.2

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1d PRA and Severe Accident Analysis Key Design Features (Sheet 2 of 6)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.4.5.1 Table 2.4.5-5 ITAAC #11 2.7.1.2 Table 2.7.1.2-5 ITAAC #8.a 2.7.1.11 Table 2.7.1.11-5 ITAAC #18	In high RCS pressure sequences, a fast depressurization of the RCS by using the EFW pumps to remove heat through the SGs and by manually opening the MSRVs allows alternate core cooling injection using the CS/RHR pumps.	Table 19.1-119
2.4.5.1 Table 2.4.5-5 ITAAC #1.a	CSS/RHRS provides water to flood the reactor cavity.	Table 19.1-119
2.4.5.1 Table 2.4.5-5 ITAAC #2	Upgraded piping design pressure for the residual heat removal system (RHRS) results in a negligible frequency of occurrence of an inter-system LOCA.	19.1.3.4 Table 19.1-1 Table 19.1-119
2.4.5.1 Table 2.4.5-5 ITAAC #1.a, #2, 7.a	Two motor operated valves in series on the RHR suction line with power lockout capability during normal power operation minimize the probability of RCS pressure entering the RHR system. Even if both these valves are opened during normal power operation, the RHR system is designed to discharge the RCS inventory to the in-containment RWSP. The RHRS is designed to prevent an interfacing system LOCA by having a design rating of 900 lb.	5.4.7.1 Table 19.1-119
2.4.5 Table 2.4.5-5 ITAAC #9	RHR suction isolation valves can be manually closed to isolate a LOCA in the RHR line.	Table 19.1-119
2.4.5 Table 2.4.5-5 ITAAC #1.a	One normally closed air-operated valve is installed in each of two low-pressure letdown lines that are connected to two of four RHR trains.	Table 19.1-119
2.4.5.1 Table 2.4.5-5 ITAAC #1.a	To prevent loss of RCS inventory during mid-loop operation and support severe accident prevention, the low-pressure letdown line isolation valves are automatically closed and the CVCS is isolated from the RHRS, after receiving a RCS loop low-level signal.	5.4.7.2 19.1.3.4 Table 19.1-1 Table 19.1-119 19.2.2.2
2.4.6 Table 2.4.6-5 ITAAC #1.a 2.7.6.3 Table 2.7.6.3-5 ITAAC #1	CVCS charging pumps can provide decay heat removal in the event of loss of RHR and SG cooling. The RWSP can provide makeup to the RWSAT for charging pump suction.	Table 19.1-119

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1d PRA and Severe Accident Analysis Key Design Features (Sheet 3 of 6)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.5.1 Table 2.5.1-3 Table 2.5.1-6 ITAAC #4 2.5.4 Table 2.5.4-2 ITAAC #2	Containment isolation and heat removal can be manually actuated in the event of failure of the containment isolation signal.	Table 19.1-119
2.5.1 Table 2.5.1-3 Table 2.5.1-6 ITAAC #4 2.5.4 Table 2.5.4-2 ITAAC #2	ESF actuation can be performed manually in the event of failure of automatic ESF actuation.	Table 19.1-119
2.6.1 Table 2.6.1-3 ITAAC #1 2.6.5 Table 2.6.5-1 ITAAC #1	Non-Class 1E 6.9kV permanent buses P1 and P2 are also connected to the non-Class 1E A-AAC GTG and B-AAC GTG, respectively. The loads which are not safety-related but require operation during LOOP are connected to these buses.	8.3.1.1.1 Table 19.1-119
2.6.1 Table 2.6.1-3 ITAAC #24	Non-segregated busducts/cable buses to safety buses in the T/B electrical room are segregated into two groups by qualified fire barriers.	8.3.1.1.8 9.5.1 19.1.5.2 Table 19.1-1 Table 19.1-119
2.6.4 Table 2.6.4-1 ITAAC #3, #11, #32	The GTG does not need a cooling water system. Cooling of GTG is achieved by air ventilation system GTG combustion air intake and exhaust system for each of the four GTGs supply combustion air of reliable quality to the gas turbine and exhausts combustion products from the gas turbine to the atmosphere. The air intake also provides ventilation/cooling air to the GTG assembly.	9.5.5 9.5.8 Table 19.1-119
2.6.5.1 Table 2.6.5-1 ITAAC #13, #14	Common cause failure between class 1E GTG and non-class 1E GTG supply is minimized by design characteristics. The AAC power sources are of different size, have different starting system from the EPS.	8.4.1.3 Table 19.1-119
2.6.5.1 Table 2.6.5-1 ITAAC #6	In the event of SBO, power to one Class 1E 6.9kV bus can be restored manually from the AAC GTG. Power to the shutdown buses can be restored from the AAC sources within 60 minutes.	8.3.1.1.2.4 8.4.1.2 8.4.1.3 Table 19.1-119

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1d PRA and Severe Accident Analysis Key Design Features (Sheet 4 of 6)

Tier 1 Ref.[1]	Key Design Features	Tier 2 Location[2]
2.6.5.1 Table 2.6.5-1 ITAAC #1	Alternate ac power supported by two non-Class 1E GTGs is incorporated as a countermeasure against SBO. Alternate ac power sources can supply power to two of the four safety buses in case class 1E GTGs fail during loss of offsite power. AAC power sources are non-Class 1E and non-seismic. AAC power sources supply power to loads required to bring and maintain the plant in a safe shutdown condition for a station blackout (SBO) condition.	8.4.1.3 19.1.3.1 19.1.3.4 19.1.4.1 Table 19.1-1 19.2.2
2.6.5.1 Table 2.6.5-1 ITAAC #1, #5, #13, #14	AAC power sources use different rating GTGs than the Class 1E EPSs, with diverse starting system, independent and separate auxiliary and support systems to minimize common cause failure.	8.4.1.3 Table 19.1-119
2.7.1.2 Table 2.7.1.2-5 ITAAC #8.a 2.7.1.11 Table 2.7.1.11-5 ITAAC #8.a, #18	Main steam depressurization valves (MSDVs) on intact SG(s) can be opened and EFW flow established to promote heat removal and RCS depressurization.	Table 19.1-119
2.7.1.11.1 Table 2.7.1.11-5 ITAAC #1.a	Each EFW pump discharge line connects with a cross-tie line using normally closed motor-operated isolation valves to provide separation of four trains. Operation to open the EFW cross-tie valve when an EFW pump is not available is an important feature to reduce core damage frequency.	10.4.9.2 19.1.4.1 19.2.2
2.7.3.1 Table 2.7.3.1-5 ITAAC #10.a	In the case of failure of running ESWS, with ESW flow rate – low, the standby ESW pump can be started in order to maintain ESWS operation.	Table 19.1-119
2.7.3.1 Table 2.7.3.1-5 ITAAC #1.a	In the case of ESW pump discharge blockage, flow can be switched from the blocked strainer to the standby strainer.	Table 19.1-119
2.7.3.3 Table 2.7.3.3-5 ITAAC #8.a	CCW header tie line isolation valves may be manually closed to achieve header separation in the event of failure of automatic valve closure.	Table 19.1-119
2.7.3.3 Table 2.7.3.3-5 ITAAC #10.a	In the case of failure of running CCWS, with CCW flow rate – low, the standby CCW pump can be started in order to maintain CCWS operation.	Table 19.1-119
2.7.3.3 Table 2.7.3.3-5 ITAAC #1.a	If loss of seal injection should occur, CCW continues to provide flow to the thermal barrier heat exchanger; which cools the reactor coolant. The pump is able to maintain safe operating temperatures and operate safely long enough for safe shutdown of the pump.	5.4.1.1.3 Table 19.1-119

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1d PRA and Severe Accident Analysis Key Design Features (Sheet 5 of 6)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.7.3.3 Table 2.7.3.3-5 ITAAC #1.a Table 2.7.3.6-3 ITAAC #1	Alternate containment cooling via natural CV circulation can be established by pressurizing CCWS with nitrogen, disconnecting nonessential heat loads and connecting to the containment fan cooler units.	Table 19.1-119
2.7.3.6.1 Table 2.7.3.6-3 ITAAC #1	Non-essential chilled water system provides alternate component cooling water to charging pumps in order to maintain RCP seal water injection.	Table 19.1-1 Table 19.1-119
2.7.3.6 Table 2.7.3.6-3 ITAAC #1 2.7.5.3.1.2 Table 2.7.5.3-1	Alternate containment cooling using the containment fan cooler system is provided to prevent containment over pressure even in case of containment spray system failure. The fan cooling units are cooled by the component cooling water system. The containment fan cooler system enhances condensation of surrounding steam by natural convection and thus enhances continuous depressurization of the containment.	9.4.6.2 19.1.3.1 Table 19.1-1 19.1.3.2 Table 19.1-119 19.2.3.3.8
2.7.6.3 Table 2.7.6.3-5 ITAAC #1	As a countermeasure for loss of RHR, RCS makeup by gravity injection from spent fuel pit is available when the RCS in atmospheric pressure.	19.1.6.1 Table 19.1-1 Table 19.1-119
2.7.6.9.1 Table 2.7.6.9-2 ITAAC #6.a	The fire protection water supply system (FSS) is available as an alternative component cooling water source for severe accident prevention, including support of CVCS for RCP seal water injection.	9.5.1.2.2 19.1.3.2 19.1.5.3.2 19.2.3.3.3 Table 19.1-119
Table 2.7.6.9-2 ITAAC #6.b	The FSS is available to the containment spray system and water injection to the reactor cavity for severe accident mitigation.	9.5.1.2.2 19.1.3.2 19.2.3.3.3 Table 19.1-119
Table 2.11.1-2 ITAAC #4	A set of drain lines is provided from the steam generator compartments to the reactor cavity to flood the reactor cavity with containment spray water during severe accidents.	19.1.3.2 Table 19.1-119
2.11.1.1 Table 2.11.1-2 ITAAC #5	The core debris trap enhances capturing of ejected molten core in the reactor cavity to support severe accident mitigation. The consequences of a postulated high pressure melt ejection accident, including direct containment heating, are mitigated by the debris trap in the reactor cavity as well as no direct pathway to the upper compartment for the impingement of debris on the containment shell.	19.1.3.2 Table 19.1-1 Table 19.1-119 19.2.3.3.4
2.11.1.1 Table 2.11.1-2 ITAAC #6	The geometry of the reactor cavity is designed to assure adequate core debris coolability. Sufficient reactor cavity floor area and appropriate reactor cavity depth are provided to enhance spreading debris bed for better coolability to support severe accident mitigation.	19.1.3.2 Table 19.1-119 19.2.3.3.3

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Table 14.3-1d PRA and Severe Accident Analysis Key Design Features (Sheet 6 of 6)

Tier 1 Ref.(1)	Key Design Features	Tier 2 Location(2)
2.11.1.1 Table 2.11.1-2 ITAAC #7	There is a liner-plate-covering concrete as the floor surface of the reactor cavity, which supports severe accident mitigation by protecting against short-term attack by relocated core debris.	Table 19.1-119 19.2.3.3.3
2.11.2.1 Table 2.11.2-2 ITAAC #14	Main containment penetrations are isolated automatically even when SBO occurs and alternative ac generators are not available.	8.3.1.1.5 Table 8.3.1-10 Table 19.1-1 Table 19.1-119
2.11.4.1 Table 2.11.4-1 ITAAC #1, #3, #4, #5, #6	The CHS includes 1. a single hydrogen monitor located outside of containment that measures hydrogen concentration in containment air extracted from the containment. 2. 20 igniters installed inside the containment, designed to burn hydrogen continuously to maintain hydrogen concentration below the low limit of global burn (approximately 10% hydrogen in air), thereby preventing further hydrogen accumulation that could become a threat to containment integrity. 3. The igniters start upon receipt of an ECCS actuation signal and are powered by two non-class 1E buses with non-class 1E GTGs.	6.2.5 Figure 6.2.5-1 19.1.3.2 19.2.3 Table 19.1-119
2.13 Table 2.13-1 ITAAC #1	US-APWR design reliability assurance program provides reasonable assurance that: 1) the US-APWR is designed and constructed in a manner that is consistent with the assumptions and risk insights for the SSCs and 2) the SSCs function reliably when challenged.	17.4 Table 17.4-1

NOTES: (1) Source: Tier 1 section or table. (2) Tier 2 location or table where addressed.

Tier-2

Chapter 16

SR 3.5.4 RWSP

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE	FREQUENCY
SR 3.5.4.1	----------NOTE---------- Only required to be performed when containment air temperature is < 32°F or >120°F. ---------- Verify RWSP borated water temperature is ≥ 32°F and ≤ 120°F.	[24 hours OR In accordance with the Surveillance Frequency Control Program]
SR 3.5.4.2	Verify RWSP borated water volume is ≥ ~~583,340 gallons.~~ 76,600 ft3(573,000 gallons).	[7 days OR In accordance with the Surveillance Frequency Control Program]
SR 3.5.4.3	Verify RWSP boron concentration is ≥ 4000 ppm and ≤ 4200 ppm.	[7 days OR In accordance with the Surveillance Frequency Control Program]
SR 3.5.4.4	Verify isotopic concentration of B-10 in the RWSP is ≥ 19.9% (atom percent).	[24 hours OR In accordance with the Surveillance Frequency Control Program]

Tier-2

Chapter 19

19.1 Probabilistic Risk Assessment

The dominant scenarios, dominant cutsets and basic event importance (FV importance and RAW) for the internal flood at LPSD (POS 8-1) are shown in Table 19.1-127, Table 19.1-128, Table 19.1-129 and Table 19.1-130. Important SSCs for internal flood at LPSD are RHR, CCWS and supporting power supply systems. Risk from internal flood at LPSD has been very small though it has been estimated using conservative assumptions.

19.1.7 PRA-Related Input to Other Programs and Processes

The following subsections describe PRA-related input to various programs and processes.

19.1.7.1 PRA Input to Design Programs and Processes

The US-APWR PRA is an integral part of the design process and has been used to optimize the plant design with respect to safety. The PRA models and results have influenced the selection of design alternatives such as four train core cooling systems, an in-containment RWSP, full digital I&C systems.

The US-APWR is expected to perform better than current operating plants in the area of severe accident safety performance since prevention and mitigation of severe accidents, as shown in Table 19.1-1, have been addressed during the design stage, taking advantage of PRA results and severe accident analysis. The PRA results indicate that the US-APWR design results in a low level of risk and meets the CDF, LRF, and containment performance goals for new generation PWRs. Key insights and assumptions are summarized in Table 19.1-119.

19.1.7.2 PRA Input to the Maintenance Rule Implementation

PRA input is provided as required to develop the Maintenance Rule, discussed in Chapter

19.1.7.3

Ultimate
support
perform

19.1.7.4

Risk sig
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external
input is
discuss

Add the following paragraph:
The PRA has been used to evaluate the contribution to plant risk from inadequate containment pressure with regards to crediting containment accident pressure in determining available NPSH. In the evaluation of available NPSH of safety injection pumps and CS/RHR pumps it has been assumed that the containment pressure is equal to the RWSP fluid vapor pressure for high sump fluid temperatures (vapor pressure greater than initial containment atmospheric pressure). Events which could reduce containment accident pressure (e.g., impaired containment integrity or operation of heat removal systems at too high a rate) would also accordingly reduce the RWSP fluid temperature, such that the containment accident pressure still bounds the RWSP fluid vapor pressure. However, a rapid depressurization of containment during these periods of high RWSP temperature could potentially cause a loss of sufficient NPSH margin (e.g., due to flashing). An evaluation of the contribution to plant risk from inadequate containment pressure during periods of high sump temperatures during post accident conditions has been performed for all hazard groups. The evaluated core damage risk from inadequate containment pressure is two orders of magnitude lower than the core damage frequency. The contribution to plant risk from inadequate containment pressure was therefore considered negligible.

19.1.7.5 PRA Input to the Regulatory Treatment of Non-Safety-Related Systems Program

PRA information for the RAP includes non-safety risk significant SSCs.

drive the risk to unacceptable levels with respect to NRC goals: Subsection 19.1.4, 19.1.5, 19.1.6

- To reduce or eliminate known weaknesses of existing operating plants that are applicable to the new design, by introducing appropriate features and requirements: Subsection 19.1.3
- To select among alternative features, operational strategies, and design options: Subsection 19.1.3
- To develop an in-depth understanding of the design's robustness and tolerance of severe accidents initiated by either internal or external events: Subsections 19.1.4, 19.1.5, 19.1.6
- To examine the risk-significance of specific human errors associated with the design, and characterize the significant human errors in preparation for better training and more refined procedures: Subsections 19.1.4, 19.1.5, 19.1.6
- To determine how the risk associated with the design compares against the NRC goals of less than 1E-4/year for core damage frequency (CDF) and less than 1E-6/year for large release frequency (LRF): Subsections 19.1.4, 19.1.5, 19.1.6
- To determine containment performance against the NRC containment performance goal, which includes a deterministic goal that containment integrity be maintained for approximately 24 hours following the onset of core damage for the more likely severe accident challenges and a probabilistic goal that the conditional containment failure probability (CCFP) be less than approximately 0.1 for the composite of core damage sequences assessed in the PRA: Section 19.2
- To assess the balance of preventive and mitigate features of the design, including consistency with guidance in SECY-93-087 (Reference 19.1-45) and the associated staff requirements memoranda: Section 19.2
- To demonstrate that the plant design represents a reduction in risk compared to existing operating plants: Subsection 19.1.3
- To demonstrate that the design addresses known issues related to the reliability of core and containment heat removal systems at some operating plants: Subsection 19.1.3, Section 19.2
- To support regulatory oversight processes and programs that will be associated with plant opera
factors, mainter
- To identify and
inspection, test
program (RAP),
items and interf

Add the following bullet:

To demonstrate that contribution to plant risk is insignificant in determining available NPSH from crediting containment accident pressure during periods of high sump temperatures (vapor pressure greater than initial containment pressure): Subsection 19.1.7.1