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TOKYO, JAPAN

July 29, 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-11247

Subject: Transmittal of the US-APWR DCD (Revision 3) GSI-191 Tracking Report, (July 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-11193 from Y. Ogata (MHI) to the U.S. NRC, "Transmittal of the Technical Report entitled "US-APWR Sump Strainer Performance" (MUAP-08001 Revision 4), dated June 29, 2011.

[3] Letter MHI Ref: UAP-HF-08305 from Y. Ogata (MHI) to the U.S. NRC, "Transmittal of the Technical Report entitled "US-APWR Sump Strainer Downstream Effects" (MUAP-08013 Revision 0), dated December 26, 2008.

[4] Letter MHI Ref: UAP-HF-11181 from Y. Ogata (MHI) to the U.S. NRC, "MHI response to US-APWR DCD RAI 740-5719 Revision 2 (SRP 06.02.02), dated June 14, 2011.

With this letter, Mitsubishi Heavy Industries, Ltd. ("MHI") transmits to the U.S. Nuclear Regulatory Commission ("NRC") the document as listed in Enclosures.

Enclosed is the first DCD GSI-191 Tracking Report (TR) associated with GSI-191 Closure Activities committed to the NRC in Reference 1. The first GSI-191 TR is provided for advance staff review to confirm that the required information is included in the DCD Chapter 6. The additional information prepared in the TR is as follows:

1. Break selection
2. Debris source term
3. Debris generation
4. Debris characteristics
5. Debris transport
6. Debris head loss
7. Net positive suction head and air injection
8. Coating evaluation
9. Chemical effects
10. Upstream effects
11. Downstream effects (In-Vessel and Ex-Vessel)

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As scheduled in Reference 1, MHI is continuing the GSI-191 Closure Actions associated with the above Items 6, 7, 8, and 11. MHI is performing; a) post-assessment of strainer head loss tests and finalization of the NPSH calculation in the technical report MUAP-08001 "Sump Strainer Performance" (Reference 2), and; b) implementation of the core inlet blockage tests and finalization of the technical report MUAP-08013 "Downstream Effects" (Reference 3). After completion of these actions, MHI will update the above Items 6, 7, 8, and 11 in the final GSI-191 TR.

MHI's response to RAI 740-5719 (Reference 4), which is associated with the above Item 10, has been incorporated into the first GSI-191 TR. Since MHI and the NRC are continuing to discuss the resolution of this RAI, the above Item 10 will possibly be updated in a future TR.

The first GSI-191 TR does not include changes to chapters other than Chapter 6. The final GSI-191 TR, which will cover all chapters for completeness, will be submitted to the NRC by the end of August, 2011.

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 eventually be consolidated into the standard Tracking Reports after closure of all GSI-191 activites.

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,

Y. Ogata

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

Enclosures:

1. US-APWR DCD (Revision 3) GSI-191 Tracking Report "Proposed Changes for GSI-191 Closure Activities" (July 2011 Version)

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

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Enclosure 1

UAP-HF-11247
Docket No. 52-021

US-APWR DCD (Revision 3)

GSI-191 Tracking Report

Proposed Changes for GSI-191 Closure Activities

(July 2011 Version)

This is the first 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 is provided for advance staff review to confirm that the required information is included in DCD Chapter 6. The first GSI-191 TR does not include changes to other chapter besides Chapter 6. The final GSI-191 TR, which will cover all chapters for completeness, will be submitted to the NRC by the end of August, 2011.

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.	-
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	Response to RAI No. 740 MHI Letter No. UAP-HF-11181 Date 06/14/2011	Revised Table 6.2.1-3 and 6.2.1-5 (Sheet 1 of 2) to reasons as discussed in RAI 740-5719.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00001	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.	-
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.	-

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	6.2.2.3.1	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.	-
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	Table 6.2-XX	[TBD]	GSI-191, Design Basis Debris	Added table to describe design-basis debris for strainer performance evaluation.	-
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.	-

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	6.2.2.3.6	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).	-
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.	-

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	6.2.2.3.13	6.2-50	GSI-191, Downstream effects	Added section to describe in-vessel (core blockage) performance downstream of strainer.	-
MIC-03.06-00007	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.	-
MIC-03.06-00008	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-03.06-00009	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-03.06-00010	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".	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
			Clarification	Add information to address the consistency of the design with the Regulatory Position.	-
MIC-03.06-00011	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-03.06-00012	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-03.06-00013	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-03.06-00014	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.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00015	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.	-
MIC-03.06-00016	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-03.06-00017	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-03.06-00018	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-03.06-00019	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)	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00020	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.	-
MIC-03.06-00021	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-03.06-00022	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-03.06-00023	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-03.06-00024	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.)	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00025	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.	-
MIC-03.06-00026	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-03.06-00027	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.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00028	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-03.06-00029	Table 6.2.2-2 (Sheet 13 of 17) Regulatory position 1.3.2.7	6.2-183	Clarification	Address contrastively with regulatory position regarding debris degradation in the analysis.	-
MIC-03.06-00030	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-03.06-00031	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-03.06-00032	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.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00033	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-03.06-00034	Table 6.2.2-2 (Sheet 14 of 17) Regulatory position 1.3.3.3.	6.2-184	Clarification	Address that CFD was not utilized for the US-APWR debris transport analysis.	-
MIC-03.06-00035	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-03.06-00036	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-03.06-00037	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.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00038	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 points has been surveyed and assessed in the evaluation.	-
MIC-03.06-00039	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-03.06-00040	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.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00041	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.	-
MIC-03.06-00042	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-03.06-00043	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-03.06-00044	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.	-

Change ID No.	Location (e.g., subsection, table, or figure)	DCD Rev.3 Page *	Reason for Change	Change Summary	Rev. of T/R
MIC-03.06-00045	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 under different debris combinations.	-
MIC-03.06-00046	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-03.06-00047	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-03.06-00048	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-03.06-00049	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-03.06-00050	Table 6.3-3 GSI-191	6.3-33	Clarification	Add statement to refer new subsection for addressing GSI-191.	-
MIC-03.06-00051	Table 6.3-4 GL 98-04	6.3-39	Clarification	Add statement to refer new subsections for addressing GL 98-04.	-
MIC-03.06-00052	Table 6.3-4 BL 93-02	6.3-41	Clarification	Add statement to refer new subsection for addressing BL 93-02.	-
MIC-03.06-00053	Table 6.3-4 BL 95-02	6.3-41	Clarification	Add statement to refer new subsection for addressing BL 95-02.	-
MIC-03.06-00054	Table 6.3-4 BL 96-03	6.3-42	Clarification	Add statement to refer new subsection for addressing BL 96-03.	-
MIC-03.06-00055	Table 6.3-4 GL 2004-02	6.3-43	Editorial correction	Delete referred technical reports from the Table 6.3-4.	-
MIC-03.06-00056	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-03.06-00057	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-03.06-00058	Table 6.3-5 RWSP (Sheet 3 of 3)	6.3-47	Clarification	Updated peak temperature (i.e., 270F)	-

*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.

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~~ 270. 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.

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~~ Figure 6.2.1-16. ~~The debris~~ that interceptor , see Figure 6.2.1-12, 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~~ The design basis of postulated debris is defined as ~~"small"~~ smalls" and all of debris is ~~considered reachable~~ assumed enter 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~~ this 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.

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 the Safety Evaluation (SE) of NEI 04-07, "PWR Sump Performance Evaluation Methodology" and conforms ~~to~~ with the guidance in RG 1.82 (Ref. 6.2-23).

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:

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

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~~

- ~~Debis 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.~~

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

that

, aluminum

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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

to ensure that

Insert G

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

in containment

allocated

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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.

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

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

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 6.2.2-2 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).	Replace with "The ECC/CS strainers" Insert "all design basis" Add "loads and minimize debris head loss to maintain NPSH in safe." ~~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.

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)~~
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.

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.

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."

Replace with "Appendix-B"

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 ...."

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. Replace with "the ECC/CS".
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.

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. Replace with "the SE of NEI 04-07".
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: "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. Replace with "1.3.1.1".	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. Replace with "1.3.4."	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~~.

Insert row No 1.3.1.3 - 1.3.1.6 from below pages.

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)

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

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).

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). 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 ....".
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 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.	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." ~~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).~~ Replaced with: "The US-APWR conservatively assumes that all generated debris is transported to the sump."
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[illegible] water following a LOCA. Thi[illegible] 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. Replace with "1.3.3.4"	~~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: "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."

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."

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 ft² 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).~~ 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."
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. 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."

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

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. 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 6.2.2.3.13 and 6.2.2.3.14, "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, inventory of: aluminum, latent debris and miscellaneous debris) introduced into the containment that could contribute to sump strainer blockage.

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-XX. More detailed information is provided in the Sump Strainer Performance Evaluation document (Ref. 6.2-34).

Table 6.2-XX 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) 0.1875 (ft^3) of fiber debris
(2) 200 (lbs) of coating debris

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.X.X.

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.

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)

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 $Na_2B_40_7 \cdot 10\ H_20$. (Sodium tetra-borate decahydrate is also known as “borax” and can be written $B_4O_7Na_2 \cdot 10\ H_20$.)

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. Insert "6.2.2.2.6 and "
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
NPSH Required	15.7 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

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°F
Temperature during normal operation	70 ~ 120°F
Peak Temperature following LOCA	Approximately ~~250~~ 270 °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.