ENCLOSURE 3

APP-GW-GLE-002, Revision 3 (Non-Proprietary)

"Impacts to the AP1000 to Address Generic Safety Issue (GSI)-191"

APP-GW-GLE-002
Revision 3

IMPACTS TO THE AP1000 TO ADDRESS GENERIC SAFETY ISSUES (GSI)-191

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Title: Impacts to the AP1000 DCD to Address Generic Safety Issue (GSI)-191

Brief Description of the Impact (what is being changed and why):

The AP1000 Design Control Document, Revision 17, (Tier 1 and Tier 2) is being amended to address Nuclear Regulatory Commission (NRC) Generic Letter 2004-02, in accordance with the responses to Requests for Additional Information (RAIs) from the NRC.

SRP Section Impacted:
The change affects DCD Sections 6.1, 6.2, and 6.3 and DCD Tier 1 Section 2.2.

This evaluation is prepared to document the Design Control Document (DCD) changes described above. The DCD change is a departure from Tier 1 and Tier 2 information of the AP1000 DCD Revision 17. Changes that were implemented in Revision 17 of the DCD were included in APP-GW-GLE-002 Rev. 1 The changes identified in this document are intended to be included in a revision to the DCD and in the review of the Design Certification amendment or included as generic information in plant specific FSARs. Changes to Tier 1 and Tier 2 information require review and approval by the NRC.

I. TECHNICAL DESCRIPTION

The DCD Tier 1 and Tier 2 information needs to be updated to clarify specifications on the required application and use of high density safety grade coatings on engineered components, use of Metal Reflective Insulation (MRI) or equivalent within postulated Loss of Coolant Accident (LOCA) Zones of Influence, In-containment Refueling Water Storage Tank (IRWST) and containment recirculation screen mesh sizes, allowable aluminum content, physical property restrictions on miscellaneous materials associated with signs, tags, and tape, and magnitude and type of debris loading. The following list of RAIs are the driving factor behind the DCD Tier 1 and Tier 2 revisions delineated in this document:

1. RAI-SRP6.2.2-SPCV-19
2. RAI-SRP6.2.2-SPCV-17
3. RAI-SRP6.2.2-SPCV-12
4. RAI-SRP6.2.2-CIB1-22
5. RAI-SRP6.2.2-CIB1-21
6. RAI-SRP6.2.2-CIB1-20
7. RAI-SRP6.2.2-SRSB-05

II. CHANGE JUSTIFICATION

The change is made to address the industry issue of sump screen blockage and emergency core cooling performance. Westinghouse and the NRC have previously communicated and agreed to the approach Westinghouse is taking for closure of Generic Safety Issue-191 with the guidance of the NRC. This report represents one piece of the entire plan to confirm AP1000's compliance with GL-2004-02 (Reference 2).

III. REGULATORY IMPACT

A. EVALUATION OF DEPARTURE FROM TIER 1 & 2 INFORMATION (Check correct response and provide justification for that determination under each response)

10 CFR Part 52, Appendix D, Section VIII. B.5.a. provides that an applicant for a combined licensee who references the AP1000 design certification may depart from Tier 2 information, without prior NRC approval, if it does not require a license amendment under paragraph B.5.b. These questions are addressed here to provide an

evaluation of the regulatory impact. Regardless of the answers to these questions these changes are being provided to the NRC for review and approval as part of the design certification amendment. Also changes to Tier 1 require NRC review and approval. The questions below address the criteria of B.5.b.

1. Does the proposed departure result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the plant-specific DCD? ☐ YES ☒ NO

2. Does the proposed departure result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety and previously evaluated in the plant-specific DCD? ☐ YES ☒ NO

3. Does the proposed departure Result in more than a minimal increase in the consequences of an accident previously evaluated in the plant-specific DCD? ☐ YES ☒ NO

4. Does the proposed departure result in more than a minimal increase in the consequences of a malfunction of an SSC important to safety previously evaluated in the plant-specific DCD? ☐ YES ☒ NO

5. Does the proposed departure create a possibility for an accident of a different type from any evaluated previously in the plant-specific DCD? ☐ YES ☒ NO

6. Does the proposed departure create a possibility for a malfunction of an SSC important to safety with a different result than any evaluated previously in the plant-specific DCD? ☐ YES ☒ NO

7. Does the proposed departure result in a design basis limit for a fission product barrier as described in the plant-specific DCD being exceeded or altered? ☐ YES ☒ NO

8. Does the proposed departure result in a departure from a method of evaluation described in the plant-specific DCD for establishing the design bases or safety analyses? ☐ YES ☒ NO

B. IMPACT ON RESOLUTION OF A SEVERE ACCIDENT ISSUE

10 CFR Part 52, Appendix D, Section VIII. B.5.a. provides that an applicant for a combined licensee who references the AP1000 design certification may depart from Tier 2 information, without prior NRC approval, if it does not require a license amendment under paragraph B.5.c. The questions below address the criteria of B.5.c.

1. Does the proposed activity result in an impact to features that mitigate severe accidents? If the answer is Yes, answer Questions 2 and 3 below. ☐ YES ☒ NO

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2. Is there is a substantial increase in the probability of a severe accident such that a particular severe accident previously reviewed and determined to be not credible could become credible? ☐ YES ☒ NO ☐ N/A

3. Is there is a substantial increase in the consequences to the public of a particular severe accident previously reviewed? ☐ YES ☒ NO ☐ N/A

C. SECURITY ASSESSMENT

1. Does the proposed change have an adverse impact on the security assessment of the AP1000? ☐ YES ☒ NO

D. OTHER REGULATORY CRITERIA

Further guidance for this change is found in Regulatory Guide 1.82, Revision 3, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident" (Reference 1).

IV. REFERENCES

1. "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident", Regulatory Guide 1.82, Revision 3, ML033140347, United States Nuclear Regulatory Commission.
2. "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESSURIZED-WATER REACTORS", Generic Letter 2004-02 September 2004, ML042360586, United States Nuclear Regulatory Commission.
3. "AP1000 Containment Recirculation and IRWST Screen Design", TR-147, APP-GW-GLN-147, Westinghouse Electric Company LLC.
4. "AP1000 Verification of Water Sources for Long-Term Recirculation Cooling Following a LOCA", TR-026, APP-GW-GLR-079, Westinghouse Electric Company LLC.

V. DCD MARK-UP

Tier 1

1. *Table 2.2.3-4*
   a. *Item 8c-viii*
   b. *Item 8c-ix*
   c. *Item 8c-x*

Tier 2

1. *Section 6.1.1.4*
2. *Section 6.1.2.1.5*
3. *Section 6.1.2.1.6*
4. *Table 6.1-2*
5. *Section 6.3.2.2.7.1*
6. *Section 6.3.2.2.7.2*
7. *Section 6.3.2.2.7.3*
8. *Section 6.3.8.1*
9. *Figure 6.3-2*

AP1000 Design Control Document Revision 17
Tier 1 Changes

Justification for changes to Table 2.2.3-4 Item 8c)viii: *To ensure the IRWST and CR screens are constructed to prohibit debris greater than 0.0625" from transporting an ITAAC has been added to ensure the screen mesh size is ≤ 0.0625" for both the CR and IRWST screens.* ***Item 8c) ix*** *To ensure no additional debris generation results from the maximum magnitude of jet impingements associated with an ASME Class 1 line break item ix was amended to include inspections of high density coatings used on components within the ZOI of the limiting line break. Also, tags and signs within the ZOI will also be inspected to ensure composition of said items will prohibit debris transport to the containment recirculation and IRWST screens.* ***Item 8c) x:*** *Item x was amended to ensure materials used for tags, signs, etc. were of a sufficient density to ensure transport to the recirculation screens would not occur during a DBA. Additionally this section was amended to ensure coatings on said components would be of a high density ≥ 100lbm/ft^3 to prohibit transport to the screens in a DBA environment.*

Table 2.2.3-4 (cont.)
Inspections, Tests, Analyses, and Acceptance Criteria

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
	viii) Inspections of the IRWST and containment recirculation screens will be conducted. The inspections will include measurements of the pockets and the number of pockets used in each screen. The pocket frontal face area is based on a width times a height. The width is the distance between pocket centerlines for pockets located beside each other. The height is the distance between pocket centerlines for pockets located above each other. The pocket screen area is the total area of perforated plate inside each pocket; this area will be determined by inspection of the screen manufacturing drawings.	viii) The screens utilize pockets with a frontal face area of ≥ 6.2 in^2 and a screen surface area ≥ 140 in^2 per pocket. Each IRWST screen has a sufficient number of pockets to provide a frontal face area ≥ 20 ft^2, ~~and~~ a screen surface area ≥ 500 ft^2, and a screen mesh size ≤ 0.0625". Each containment recirculation screen has a sufficient number of pockets to provide a frontal face area ≥ 105 ft^2, ~~and~~ a screen surface area ≥ 2500 ft^2, and a screen mesh size ≤ 0.0625". A debris curb exists in front of the containment recirculation screens which is ≥ 2 ft above the loop compartment floor. The bottoms of the IRWST screens are located ≥ 6 in above the bottom of the IRWST.
	ix) Inspections will be conducted of the insulation used inside the containment on ASME Class 1 lines, the reactor vessel, reactor coolant pumps, pressurizer and the steam generators.	ix) The type of insulation used on these lines and equipment is a metal reflective type or a suitable equivalent.
	Inspections will be conducted of other insulation used inside the containment within the zone of influence.	The type of insulation used on these lines and equipment is a metal reflective type or a suitable equivalent.
	Inspection will be conducted of other insulation below the maximum flood level of a design basis loss of coolant accident.	The type of insulation used on these lines is metal reflective insulation, jacketed fiberglass or a suitable equivalent.

	x) Inspections will be conducted of the as-built nonsafety-related coatings or of plant records of the nonsafety-related coatings used inside containment on walls, floors, ceilings, structural steel except in the CVS room. Inspections will be conducted of the as-built nonsafety-related coatings or of plant records of the nonsafety-related coatings used on engineered components below the maximum flood level of a design basis loss of coolant accident or where there is sufficient water flow to transport debris.	x) A report exists and concludes that the coatings used on these surfaces have a dry film density of $\geq$ 100 lb/ft^3.
	Inspections will be conducted on caulking, tags and signs used inside containment below the maximum flood level of a design basis loss of coolant accident or where there is sufficient water flow to transport this caulking, signs and tags.	Tags and signs used in these locations are made of steel or a suitable equivalent. In addition, a report exists and concludes that caulking used in these locations or coatings used on these signs or tags have a dry film density of $\geq$ 100 lb/ft^3.
	Inspections will be conducted of ventilation filters and fiber producing fire barriers used inside containment within the ZOI or below the maximum flood level of a design basis loss of coolant accident.	A report exists and concludes that the ventilation filters and fire barriers in these locations has a density of $\geq$ 100 lb/ft^3.
	xi) Inspection of the as-built CMT inlet diffuser will be conducted.	xi) The CMT inlet diffuser has a flow area $\geq$ 165 in^2.

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Tier 2 Changes

***Justification for changes to DCD Tier 2 : Section 6.1.1.4** has been amended to specify requirements on the quantity and use of aluminum in containment susceptible to design basis accident conditions.*

6.1.1.4 Material Compatibility with Reactor Coolant System Coolant and Engineered Safety Features Fluids

Engineered safety features components materials are manufactured primarily of stainless steel or other corrosion-resistant material. Protective coatings are applied on carbon steel structures and equipment located inside the containment, as discussed in subsection 6.1.2.

Austenitic stainless steel plate conforms to ASME SA-240. Austenitic stainless steel is confined to those areas or components which are not subject to post-weld heat treatment. Carbon steel forgings conform to ASME SA-350. Austenitic stainless steel forgings conform to ASME SA-182. Nickel-chromium-iron alloy pipe conforms to ASME SB-167. Carbon steel castings conform to ASME SA-352. Austenitic stainless steel castings conform to ASME SA-351.

Hardfacing material in contact with reactor coolant is a qualified low- or zero-cobalt alloy, equivalent to Stellite-6. The use of cobalt-base alloys is minimized. Low- or zero-cobalt alloys used for hardfacing or other applications where cobalt-base alloys have been previously used are qualified by wear and corrosion tests. The corrosion tests qualify the corrosion resistance of the alloy in reactor coolant. Cobalt-free, wear-resistant alloys considered for this application include those developed and qualified in nuclear industry programs.

In post-accident situations where the containment is flooded with water containing boric acid, pH adjustment is provided by the release of trisodium phosphate into the water. The trisodium phosphate is held in baskets located in the floodable volume that includes the steam generator compartments and contains the reactor coolant loop.. The addition of trisodium phosphate to the solution is sufficient to raise the pH of the fluid to above 7.0. This pH is consistent with the guidance of NRC Branch Technical Position MTEB-6.1 for the protection of austenitic stainless steel from chloride-induced stress corrosion cracking. Section 6.3 describes the design of the trisodium phosphate baskets.

In the post-accident environment, both aluminum and zinc surfaces in the containment are subject to chemical attack resulting in the production of hydrogen and/or chemical precipitants that can affect long-term core cooling. The amount of aluminum allowed in containment below the maximum flood level of a design basis LOCA (refer to DCD section 6.3.2.2.7.1, item 3) will be limited to less than 60 lbs during operating conditions. A large potential source of aluminum in the AP1000 containment are the excore detectors described in Subsection 7.1.2.7.2. To avoid sump water contact with the excore detectors, they are enclosed in stainless steel or titanium housings. The non-flooded surfaces would be wetted by condensing steam but they would not be subjected to the boric acid or trisodium phosphate solutions since there is no containment spray. For this reason the amount of aluminum in the excore detectors is not applied to the 60lb weight limit restriction as they are not subject to the post-DBA accident environment as a result of steel/titanium encasement. Furthermore, other aluminum within containment encased in stainless steel/titanium that can ensure interaction with the boric acid or trisodium phosphate solutions does not occur should not be applied to the 60lb weight limit. Nonsafety-related passive autocatalytic recombiners are provided to limit hydrogen buildup inside containment.

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***Justification for changes to DCD Tier 2 : Section 6.1.2.1.5** has been amended to include discussion regarding high-density coatings on engineered components within the ZOI of a design basis accident. These comments need be incorporated to ensure no additional debris generation occurs from coating immersion or interaction with jet impingements. The discussion in this sucsection in Revision 17 that discusses why coatings on manufactured components do not detach has been deleted.*

6.1.2.1.5 Safety Evaluation

This subsection describes the basis for classifying coatings as Service Level I, II, or III. Table 6.1-2 identifies which coatings are classified as Service Level I and Service Level III.

The inorganic zinc coating on the outside of the containment shell above elevation 135′ 3″ supports passive containment cooling system heat transfer and is classified as a Service Level III coating.

The inorganic zinc coating used on the inside surface of the containment shell, greater than 7′ above the operating deck, supports the transfer of thermal energy from the post-accident atmosphere inside containment to the containment shell. Passive containment cooling system testing and analysis have been performed with an inorganic zinc coating. This coating is classified as Service Level I coating.

The AP1000 has a number of design features that facilitate the use of Service Level II coatings inside containment. These features include a passive safety injection system that provides a long delay time between a LOCA and the time recirculation starts. This time delay provides time for settling of debris. These passive systems also flood the containment to a high level which allows the use of containment recirculation screens that are located well above the floor and are relatively tall. Significant volume is provided for the accumulation of coating debris without affecting screen plugging. These screens are protected by plates located above the screens that extend out in front and to the side of the screens. Coatings are not used under these plates in the vicinity of the screens. The protective plates, together with low recirculation flow, approach velocity and the screen size preclude postulated coating debris above the plates from reaching the screens. Refer to subsection 6.3.2.2.7.3 for additional discussion of these screens, their protective plates and the areas where coatings are prohibited from being used.

The recirculation inlets are screened enclosures located near the northwest and southwest corners of the east steam generator compartment (refer to the figures in Section 6.3.2.2.7.3). The enclosure bottoms are located above the surrounding floor which prevent ingress of heavy debris (specific gravity greater than 1.05). Additionally, the screens are oriented vertically and are protected by large plates located above the screens, further enhancing the capability of the screens to function with debris in the water. The screen mesh size and the surface area of the containment recirculation screens in the AP1000, in conjunction with the large floor area for debris to settle on, can accommodate failure of coatings inside containment during a design basis accident even though the residue of such a failure is unlikely to be transported to the vicinity of the enclosures.

The AP1000 does not have a safety-related containment spray system. The containment spray system provided in the AP1000 is only used for beyond design basis events. This reduces the chance that coatings will peel off surfaces inside containment because the thermal shock of cold spray water on hot surfaces combined with the rapid depressurization following spray initiation are recognized as contributors to coating failure. Parts of the containment below elevation 110′ are flooded and water is recirculated through the passive core cooling system. However, the volume of water moved in this manner is relatively small and the flow velocity is very low.

The coating systems used inside containment also include epoxy and/or self-priming high solids epoxy coatings. These are applied to concrete substrates, as top coats over the inorganic zinc coating, and directly to steel, as noted in subsection 6.1.2.1.2. The failure modes of these systems could include delamination or peeling if the epoxy coatings are not properly applied (References 1, 2, 3). The epoxys applied to concrete and carbon steel surfaces are sufficiently heavy (dry film density greater than 100 lb/ft^3) so that transport with the low water velocity in the AP1000 containment is limited.

Inside containment, there are engineered components coated with various manufacturers' standard coating systems. *These coating systems are not required to have Class I or III safety classification as delineated in Table 6.1-2, however those that are located below the maximum flood level of a design basis loss of coolant accident or where* *there is sufficient water flow to transport debris are required to be sufficiently heavy (dry film density greater than 100 lb/ft^3) so that transport with the low water velocity in the AP1000 containment is limited.*

Requirements related to production of hydrogen as a result of zinc corrosion in design basis accident conditions, including the zinc in paints applied inside containment, were eliminated by the final rule, effective October 16, 2003, amending 10 CFR 50.44, "Standards for Combustible Gas Control System in Light-Water-Cooled Power Reactors."

***Justification for changes to DCD Tier 2 : Section 6.1.2.1.6** has been amended to specify requirements on the requirements for the coatings used on manufactured components.*

Service Level II Coatings

The use of Service Level II coatings inside containment is based on the use of selected types of coatings and the properties of the coatings. To preclude the use of inappropriate coatings, the procurement of Service Level II coatings used inside containment is considered a safety-related activity whereas the Service Level II coatings used outside the containment are nonsafety-related.

Appendix B to 10 CFR Part 50 applies to procurement of Service Level II coatings used inside containment on internal structures, including walls, floor slabs, structural steel, and the polar crane, except for such surfaces located inside the chemical and volume control system room # 11209. Service Level II coatings used in the chemical and volume control system room are not subject to procurement under 10 CFR 50, Appendix B, because the room is connected to the containment in a limited way through a drain line. *Service Level II coatings used on manufactured components are not subject to procurement under 10 CFR 50, Appendix B, because their high density limits the transport with the low water velocity in the AP1000 containment.* In addition, the drain line is routed to the waste liquid processing system sump which is located well below and separate from the recirculation screens. The specified Service Level II coatings used inside containment are tested for radiation tolerance and for performance under design basis accident conditions. Where decontaminability is desired, the coatings are evaluated for decontaminability.

The Service Level II coatings used inside containment are as shown in Table 6.1-2. The application, inspection, and monitoring of Service Level II coatings are controlled by a program described in subsection 6.1.3.2. This program is not subject to 10 CFR 50, Appendix B, quality assurance requirements.

Due to the use of modularized construction, a significant portion of the containment coatings are shop applied to the containment vessel and to piping, structural and equipment modules. This application of coatings under controlled shop conditions provides additional confidence that the coatings will perform as designed and as expected.

The coatings used in radiologically controlled areas outside containment are tested for radiation resistance and evaluated for decontaminability; they are not specified to be design basis accident tested, and they are not procured to Appendix B to 10 CFR 50. Where practical, the same coating materials are used in radiologically controlled areas outside containment as are used inside containment. This provides a high level of quality and optimizes maintenance painting over the life of the plant.

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Justification for changes to DCD Tier 2 : Table 6.1-2 *should be amended to clarify the requirements for coatings used on engineered components within the ZOI for design basis accident conditions.*

Table 6.1-2

AP1000 COATED SURFACES, CONTAINMENT SHELL AND SURFACES INSIDE CONTAINMENT

Surface	**Boundary**	**Surface Material**	**Coating**	**Coating Functions/Safety Classifications**		**Coating Classification (1)**
Containment Shell, Outside Surface	Shell surfaces above elevation 135′ 3″	Carbon Steel	Inorganic Zinc Coating	1 Promote wettability 2 Heat conduction 3 Nondetachable 4 Inhibit corrosion	1 Safety 2 Safety 3 Safety 4 Safety	Safety – Service Level III
Containment Shell, Inside Surface	Shell surfaces above 7 feet above operating deck	Carbon Steel	Inorganic Zinc Coating	1 Promote wettability 2 Heat conduction 3 Nondetachable 4 Inhibit corrosion	1 Safety (2) 2 Safety 3 Safety 4 Safety	Safety – Service Level I
Engineered Components Inside Containment	*(6)*	*Material of engineered component(6)*	*NA(6)*	*1 Ensure settling* *2 Inhibit corrosion*	*1 Safety (7)* *2 Nonsafety*	*Nonsafety (7)* *Service Level II*
Inside Containment	Areas surrounding the containment recirculation screens (3)	NA	NA	NA	NA	NA
	Concrete walls, ceilings and floors (4)	Concrete	Self-Priming High Solid Epoxy or Epoxy Coating System	1 Ensure settling 2 Prevent dusting 3 Protect from chemical attack 4 Enhance radioactive decontamination 5 Heat conduction	1 Safety (5) 2 Nonsafety 3 Nonsafety 4 Nonsafety 5 Safety (5)	Nonsafety (5) Service Level II

	Steel walls, ceilings, floors, columns, beams, braces, plates (4)	Carbon Steel	Inorganic Zinc Coating	1 Ensure settling 2 Inhibit corrosion	1 Safety (5) 2 Nonsafety	Nonsafety (5) Service Level II
	Steel walls, ceilings, floors, columns, beams, braces, plates (4)	Carbon Steel	Self-Priming High Solid Epoxy or Epoxy Top Coat Coating System	1 Ensure settling 2 Inhibit corrosion 3 Enhance radioactive decontamination 4 Heat conduction	1 Safety (5) 2 Nonsafety 3 Nonsafety 4 Safety (5)	Nonsafety (5) Service Level II

Notes:

1. The applicability of 10 CFR 50, Appendix B, and other codes and standards to coatings and their application are discussed in DCD subsection 6.1.2.1.6.
2. An inorganic zinc coating on the inside of the containment shell is not required to promote wettability, however it has been included in PCS testing and analysis and as a result is considered safety-related.
3. Areas around PXS recirculation screens do not require coatings as defined in DCD subsection 6.3.2.2.7.3.
4. 10 CFR 50, Appendix B, does not apply to DBA testing and manufacture of coatings in the CVS room inside containment as discussed in DCD subsection 6.1.2.1.6.
5. 10 CFR 50, Appendix B, applies to DBA testing and manufacture of these Service Level II coatings as discussed in DCD subsection 6.1.2.1.6.
6. *The explicit coating material is not required to be specified. However, the coating material must comply with the restrictions set forth in Section 6.1.2.1.5 and Table 6.1-2 for engineered components located below the maximum flood level for a design basis loss of coolant accident or where there is sufficient water flow to transport debris.*
7. *10 CFR 50, Appendix B, does not apply to DBA testing and manufacture of coatings used on manufactured components as discussed in DCD subsection 6.1.2.1.6.*

Justification for changes to DCD Tier 2 : Section 6.3.2.2.7.1 *should be amended to quantify the total latent amount of debris allowable within containment, and to clarify the total amount contributed by fibrous material. Also to define the transport of this debris to the screens. These markups also address debris from signs and tags. A summary of the RG 1.82 evaluation is also added.*

6.3.2.2.7.1 General Screen Design Criteria

1. Screens are designed to Regulatory Guide 1.82, including:

   - Separate, large screens are provided for each function.

   - Screens are located well below containment floodup level. Each screen provides the function of a trash rack and a fine screen. A debris curb is provided to prevent high density debris from being swept along the floor to the screen face.

   - Floors slope away from screens (not required for AP1000).

   - Drains do not impinge on screens.

   - Screens can withstand accident loads and credible missiles.

   - Screens have conservative flow areas to account for plugging. Operation of the non-safety-related normal residual heat removal pumps with suction from the IRWST and the containment recirculation lines is considered in sizing screens.

   - System and screen performance are evaluated.

   - Screens have solid top cover. Containment recirculation screens have protective plates that are located no more than 1 foot above the top of the screens and extend at least 10 feet in front and 7 feet to the side of the screens. The plate dimensions are relative to the portion of the screens where water flow enters the screen openings. *Coating debris is not transported to the containment recirculation screens, the IRWST screens, or into a DVI or a cold leg LOCA break that becomes submerged during recirculation considering the use of high density coatings discussed in DCD section 6.1.2.1.5.*

   - Screens are seismically qualified.

   - Screen openings are sized to prevent blockage of core cooling.

   - Screens are designed for adequate pump performance. AP1000 has no safety-related pumps.

   - Corrosion resistant materials are used for screens.

   - Access openings in screens are provided for screen inspection.

   - Screens are inspected each refueling.

2. Low screen approach velocities limit the transport of heavy debris even with operation of normal residual heat removal pumps.

3. Metal reflective insulation is used on ASME class 1 lines because they are subject to loss-of-coolant accidents. Metal reflective insulation is also used on the reactor vessel, the reactor coolant pumps,

the steam generators, and on the pressurizer because they have relatively large insulation surface areas and they are located close to large ASME class 1 lines. As a result, they are subject to jet impingement during loss-of-coolant accidents. A suitable equivalent insulation to metal reflective may be used. A suitable equivalent insulation is one that is enclosed such that LOCA jet impingement does not damage the insulation and generate debris or one that may be damaged by LOCA jet impingement as long as the resulting insulation debris are not transported to the containment recirculation screens, *IRWST screens, or into a DVI or a cold leg LOCA break that becomes submerged during recirculation.*

In order to provide additional margin, metal reflective insulation is used inside containment where it would be subject to jet impingement during loss-of-coolant accidents that are not otherwise shielded from the blowdown jet. As a result, fibrous debris is not generated by loss-of-coolant accidents. Insulation located *within the zone of influence (ZOI), which is* a spherical region within a distance equal to 20 inside diameters of the LOCA pipe break, is assumed to be affected by the LOCA when there are intervening components, supports, structures, or other objects. *The ZOI i*n the absence of intervening components, supports, structures, or other objects *includes* insulation in a cylindrical area extending out a distance equal to 45 inside diameters from the break along an axis that is a continuation of the pipe axis and up to 5 inside diameters in the radial direction from the axis. *A suitable equivalent insulation to metal reflective may be used as discussed in the previous paragraph.*

Insulation used inside containment, outside the ZOI but below the maximum post DBA accident LOCA floodup water level (plant elevation 110.2 feet) is metal reflective insulation, jacketed fiberglass or a suitable equivalent. A suitable equivalent insulation is one that would be restrained such that it would not be transported by the flow velocities present during recirculation and would not add to the chemical precipitates.

Insulation used inside containment, outside the ZOI but above the maximum post DBA accident LOCA floodup water level is un-jacketed fiberglass, rigid cellular glass or a suitable equivalent. A suitable equivalent insulation is one that when subjected to dripping of water from the containment dome would not add to the chemical precipitates; suitable equivalents include MRI and jacketed fiberglass.

4. Coatings are not used on surfaces located close to the containment recirculation screens. The surfaces considered close to the screens are defined in subsection 6.3.2.2.7.3. Refer to subsection 6.1.2.1.6. These surfaces are constructed of materials that do not require coatings.

5. The IRWST is enclosed which limits debris egress to the IRWST screens.

6. Containment recirculation screens are located above lowest levels of containment.

7. Long settling times are provided before initiation of containment recirculation.

8. Air ingestion by safety-related pumps is not an issue in the AP1000 because there are no safety-related pumps. The normal residual heat removal system pumps are evaluated to show that they can operate with minimum water levels in the IRWST and in the containment.

9. A commitment for cleanliness program to limit debris in containment is provided in subsection 6.3.8.1.

10. Other potential sources of fibrous material, such as ventilation filters or fiber producing fire barriers, are not located in jet impingement damage zones or *below the maximum post DBA accident LOCA floodup water level.*

11. *Other potential sources of transportable material, such as caulking, signs, equipment tags installed inside the containment below the maximum flood level or where there is sufficient water flow to transport these components are designed so that they do not produce debris that will be transported to the containment recirculation screens, IRWST screens, or into a DVI or a cold leg LOCA break location that is submerged during recirculation. Tags and signs in these locations are made of stainless steel or a suitable equivalent. A suitable equivalent sign or tag is one that is designed such that the resulting debris is not transported to the containment recirculation screens, IRWST screens, or into a DVI or a cold leg LOCA break that becomes submerged during recirculation. In addition, caulking used in these locations or coatings used on these signs or tags are sufficiently heavy (dry film density greater than 100 lb/ft^3) so that they will not be transported with the low water velocity in the AP1000 containment. Note that in determining if there is sufficient water flow to transport these materials, consideration needs to be given as to whether they are inside the ZOI because that determines whether they are in their original geometry or have been reduced to smaller pieces. One way of demonstrating that there is insufficient water flow to transport these materials is that they are located inside cabinets, boxes, or other enclosures; the enclosures do not have to be water tight but need to prevent water dripping on them from creating a flow path that would transport the debris outside the enclosure.*

12. *An evaluation consistent with Regulatory Guide 1.82, revision 3, and subsequently approved NRC guidance, has been performed (Reference 3) to demonstrate that adequate long-term core cooling is available considering debris resulting from a LOCA together with debris that exists before a LOCA. As discussed in DCD subsection 6.3.2.2.7.1, a LOCA in the AP1000 does not generate fibrous debris due to damage to insulation or other materials included in the AP1000 design. The evaluation considered resident fibers and particles that could be present considering the plant design, location, and containment cleanliness program. The determination of the characteristics of such resident debris was based on sample measurements from operating plants. The evaluation also considered the potential for the generation of chemical debris (precipitants). The potential to generate such debris was determined considering the materials used inside the AP1000 containment, the post-accident water chemistry of the AP1000, and the applicable research/testing.*

    The evaluation considered the following conservative considerations:
    - *The COL cleanliness program will limit the total amount of resident debris inside the containment to ≤150 pounds and the amount of the total that might be fiber to ≤8 pounds.*
    - *The percentage of the total resident debris that could be transported to the*
        - *Containment recirculation screens is ≤100%,*
        - *IRWST screens is ≤50%,*
        - *Core (via a DVI or a cold leg LOCA break that becomes submerged) is ≤60%.*
    - *Fibrous insulation debris is not generated and transported to the screens or into the core as discussed in item 3 above.*
    - *Metal reflective insulation including accident generated debris is not transported to the screens or into the core.*
    - *Coating debris is not transported to the screens or into the core as discussed in item 1 above.*
    - *Debris from other sources including caulking, signs and tags is not generated and transported to the screens or into the core as discussed in item 11 above.*
    - *The total amount of chemical precipitates that could form in 30 days is ≤55 pounds.*
    - *The percentage of the chemical precipitates that could be to transported to the*
        - *Containment recirculation screens is ≤100%,*

- *IRWST screens is ≤19%,*
- *Core is ≤100%.*

- *The maximum flow rates are based on operation of the PXS or the RNS*
    - *CR screens is ≤1548 gpm,*
    - *IRWST screens is ≤1548 gpm,*
    - *Core is ≤1325 gpm.*

No chemical precipitates are expected to enter the IRWST because the primary water input to the IRWST is steam condensed on the containment vessel. The 19% is based on scaling the containment recirculation screen chemical load to the IRWST screens.

The AP1000 containment recirculation screens and IRWST screens have been shown to have acceptable head losses. The head losses for these screens were determined in testing performed using the above conservative considerations. It has been shown that a head loss of 14 inches of water head is acceptable based on long term core cooling sensitivity analysis.

Considering downstream effects as well as potential bypass through a CL LOCA the core was shown to have acceptable head losses. The head losses for the core was determined in testing performed using the above conservative considerations. It has been shown that a head loss of 15 feet of water head is acceptable based on long term core cooling sensitivity analysis.

Justification for changes to DCD Tier 2 : Section 6.3.2.2.7.2 The design mesh size for the containment and IRWST recirculation screens is 0.0625 as opposed to the previous value of 0.125..

6.3.2.2.7.2 IRWST Screens

The IRWST screens are located inside the IRWST at the bottom of the tank. Figure 6.3-6 shows a plan view and Figure 6.3-7 shows a section view of these screens. Two separate screens are provided in the IRWST, one at either end of the tank. The IRWST is closed off from the containment; its vents and overflows are normally closed by louvers. The potential for introducing debris inadvertently during plant operations is limited. A cleanliness program (refer to subsection 6.3.8.1) controls foreign debris from being introduced into the tank during maintenance and inspection operations. The Technical Specifications require visual inspections of the screens during every refueling outage.

The IRWST design eliminates sources of debris from inside the tank. Insulation is not used in the tank. Air filters are not used in the IRWST vents or overflows. Wetted surfaces in the IRWST are corrosion resistant such as stainless steel or nickel alloys; the use of these materials prevents the formation of significant amounts of corrosion products. In addition, the water is required to be clean because it is used to fill the refueling cavity for refueling; filtering and demineralizing by the spent fuel pit cooling system is provided during and after refueling.

During a LOCA, steam vented from the reactor coolant system condenses on the containment shell, drains down the shell to the operating deck elevation and is collected in a gutter. It is very unlikely that debris generated by a LOCA can reach the gutter because of its location. The gutter is covered with a trash rack which prevents larger debris from clogging the gutter or entering the IRWST through the two 4 inch drain pipes. The inorganic zinc coating applied to the inside surface of the containment shell is one potential source of debris that may enter the gutter and the IRWST. As described in subsection 6.1.2.1.5, failure of this coating produces a heavy powder which if it enters the IRWST through the gutter will settle out on the bottom of the IRWST because of its high specific gravity. Settling is enhanced in the IRWST by low velocities in the tank and long tank drain down times.

The design of the IRWST screens reduces the chance of debris reaching the screens. The screens are oriented vertically such that debris that settles out of the water does not fall on the screens. The lowest screening surface of the IRWST screens is located 6 inches above the IRWST floor to prevent high density debris from being swept along the floor by water flow to the IRWST screens. The screen design provides the trash rack function. This is accomplished by the screens having a large surface area to prevent a single object from blocking a large portion of the screen and by the screens having a robust design to preclude an object from damaging the screen and causing by-pass. The screen prevents debris larger than *0.0625*" from being injected into the reactor coolant system and blocking fuel cooling passages. The screen is a type that has sufficient surface area to accommodate debris that could be trapped on the screen. The design of the IRWST screens is described further in APP-GW-GLN-147 (Reference 4).

The screen flow area is conservatively designed considering the operation of the nonsafety-related normal residual heat removal system pumps which produce a higher flow than the safety-related gravity driven IRWST injection/recirculation flows. As a result, when the normal residual heat removal system pumps are not operating there is a large margin to screen clogging.

Justification for changes to DCD Tier 2 : Section 6.3.2.2.7.3 The design mesh size for the containment and IRWST recirculation screens is 0.0625 as opposed to the previous value of 0.125..

6.3.2.2.7.3 Containment Recirculation Screens

The containment recirculation screens are oriented vertically along walls above the loop compartment floor (elevation 83 feet). Figure 6.3-8 shows a plan view and Figure 6.3-9 shows a section view of these screens. Two separate screens are provided as shown in Figure 6.3-3. The loop compartment floor elevation is significantly above (11.5 feet) the lowest level in the containment, the reactor vessel cavity. A two-foot-high debris curb is provided in front of the screens.

During a LOCA, the reactor coolant system blowdown will tend to carry debris created by the accident (pipe whip/jets) into the cavity under the reactor vessel which is located away from and below the containment recirculation screens. As the accumulators, core makeup tanks and IRWST inject, the containment water level will slowly rise above the 108 foot elevation. The containment recirculation line opens when the water level in the IRWST drops to a low level setpoint a few feet above the final containment floodup level. When the recirculation lines initially open, the water level in the IRWST is higher than the containment water level and water flows from the IRWST backwards through the containment recirculation screen. This back flow tends to flush debris located close to the recirculation screens away from the screens. A flow connection between Screen A and Screen B is provided so that both recirculation screens will operate, even in the case of a LOCA of a DVI line in a PXS valve room. Such a LOCA can flood the recirculation valves located in one of the PXS rooms before they are actuated, and the failure of these valves is assumed since they are not qualified to operate in such conditions. The recirculation valves in the other PXS valve room are unaffected.

The water level in the containment when recirculation begins is well above (~ 10 feet) the top of the recirculation screens. During the long containment floodup time, floating debris does not move toward the screens and heavy materials settle to the floors of the loop compartments or the reactor vessel cavity. During recirculation operation the containment water level will not change significantly nor will it drop below the top of the screens.

The amount of debris that may exist following an accident is limited. Reflective insulation is used to preclude fibrous debris that can be generated by a loss of coolant accident and be postulated to reach the screens during recirculation. The nonsafety-related coatings used in the containment are designed to withstand the post accident environment. The containment recirculation screens are protected by plates located above them. These plates prevent debris from the failure of nonsafety-related coatings from getting into the water close to the screens such that the recirculation flow can cause the debris to be swept to the screens before it settles to the floor. Stainless steel is used on the underside of these plates and on surfaces located below the plates, above the bottom of the screens, 10 feet in front and 7 feet to the side of the screens to prevent coating debris from reaching the screens. A cleanliness program (refer to subsection 6.3.8.1) controls foreign debris introduced into the containment during maintenance and inspection operations. The Technical Specifications require visual inspections of the screens during every refueling outage.

The design of the containment recirculation screens reduces the chance of debris reaching the screens. The screens are orientated vertically such that debris settling out of the water will not fall on the screens. The protective plates described above provide additional protection to the screens from debris. A 2-foot-high debris curb is provided to prevent high density debris from being swept along the floor by water flow to the containment recirculation screens. The screen design provides the trash rack function. This is accomplished by the screens having a large surface area to prevent a single object from blocking a large portion of the screen and by the screens having a robust design to preclude an object from damaging the screen and causing by-pass. The screen prevents debris larger than *0.0625"* from being injected into the reactor coolant system and blocking fuel cooling passages. The screen is a type that has more surface area to accommodate debris that could be trapped on the screen. The design of the containment recirculation screens is further described in APP-GW-GLN-147 (Reference 4).

Justification for changes to DCD Tier 2 : Section 6.3.8.1 *should be amended to quantify the total latent amount of debris allowable within containment, and to clarify the total amount contributed by fibrous material.*

6.3.8.1 Containment Cleanliness Program

The Combined License applicants referencing the AP1000 will address preparation of a program to limit the amount of debris that might be left in the containment following refueling and maintenance outages. The cleanliness program will limit the storage of outage materials (such as temporary scaffolding and tools) inside containment during power operation *to items that do not produce debris (physical or chemical) that could be transported to the containment recirculation screens, the IRWST screens, or into a DVI or a cold leg LOCA break that becomes submerged during recirculation. The cleanliness program shall limit the amount of latent debris located within containment to less than 150 pounds with less than or equal to 8 pounds being composed of fibrous material.*

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Justification for changes to DCD Tier 2 : Figure 6.3-2, note 13, *should be amended to identify that the gutter drain line termination point is well away from the IRWST screens and close to the tank floor to facilitate settling of coating debris before it is transported to the IRWST screens. .*

13. GUTTER IS PROVIDED AT OPERATING DECK ELEV. TO COLLECT CONDENSATE FROM CONTAINMENT SHELL. SUMP IS PROVIDED WITH NORMALLY OPEN DRAIN TO CONTAINMENT SUMP. CLOSING V130A *OR* V130B CAUSES DRAIN TO OVERFLOW INTO IRWST. OVERFLOW LINE TERMINATES *HORIZONTLLY 12 FEET AWAY FROM IRWST SCREEN FACE AND WITHIN 5 FEET OF THE IRWST FLOOR*. GUTTER IS COVERED BY TRASH RACK.