ENCLOSURE 3

APP-GW-GLE-002, Revision 4 (Non-Proprietary)

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

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Document Number: APP-GW-GLE-002 **Revision Number:** 4

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 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-22
3. RAI-SRP6.2.2-SPCV-24
4. RAI-SRP6.2.2-CIB1-24
5. RAI-SRP6.2.2-SRSB-16
6. RAI-SRP6.2.2-SRSB-23

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

2. Is there is a substantial increase in the probability of a severe accident such that a particular ☐ YES ☒ NO

severe accident previously reviewed and determined to be not credible could become credible? ☐ 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*

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Tier 1 Changes

Justification for changes to Table 2.2.3-4

Item 5a) ii) and iii): *To ensure that the screens are designed for the applicable requirements a design report is required for both the as designed screen and the as installed screen. .*

Item 8c) ix): *To ensure that if insulation other than MRI is used in the specified locations that a report exists and concludes that that insulation is a suitable equivalent. The DCD contains words that define the requirements for the report.*

Item 8c) x): *Item x was amended to require inorganic zinc coatings used in the specified locations to be safety – service level I. It was also 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 require a report to show that lighter weight caulking, signs or tags did not transport.*

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

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
4.a) The components identified in Table 2.2.3-1 as ASME Code Section III retain their pressure boundary integrity at their design pressure.	A hydrostatic test will be performed on the components required by the ASME Code Section III to be hydrostatically tested.	A report exists and concludes that the results of the hydrostatic test of the components identified in Table 2.2.3-1 as ASME Code Section III conform with the requirements of the ASME Code Section III.
4.b) The piping identified in Table 2.2.3-2 as ASME Code Section III retains its pressure boundary integrity at its design pressure.	A hydrostatic test will be performed on the piping required by the ASME Code Section III to be hydrostatically tested.	A report exists and concludes that the results of the hydrostatic test of the piping identified in Table 2.2.3-2 as ASME Code Section III conform with the requirements of the ASME Code Section III.
5.a) The seismic Category I equipment identified in Table 2.2.3-1 can withstand seismic design basis loads without loss of safety function.	i) Inspection will be performed to verify that the seismic Category I equipment and valves identified in Table 2.2.3-1 are located on the Nuclear Island.	i) The seismic Category I equipment identified in Table 2.2.3-1 is located on the Nuclear Island.
	ii) Type tests, analyses, or a combination of type tests and analyses of seismic Category I equipment will be performed.	ii) A report exists and concludes that the seismic Category I equipment can withstand seismic design basis dynamic loads without loss of safety function. For the PXS containment recirculation and IRWST screens, a report exists and concludes that the screens can withstand seismic dynamic loads and also post accident operating loads including head loss and debris weights.
	iii) Inspection will be performed for the existence of a report verifying that the as-installed equipment including anchorage is seismically bounded by the tested or analyzed conditions.	iii) A report exists and concludes that the as-installed equipment including anchorage is seismically bounded by the tested or analyzed conditions. For the PXS containment recirculation and IRWST screens, a report exists and concludes that the as-installed screens including their anchorage is bounded by the seismic loads and also post accident operating loads including head loss and debris weights.

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, 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, 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. If an insulation other than metal reflective insulation is used, a report must exist and conclude that the insulation is 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. If an insulation other than metal reflective insulation is used, a report must exist and conclude that the insulation is 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. If an insulation other than metal reflective or jacketed fiberglass insulation is used, a report must exist and conclude that the insulation is 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 components below the maximum flood level of a design basis loss of coolant accident or located above the max flood level and not inside cabinets or enclosures.	x) A report exists and concludes that the coatings used on these surfaces have a dry film density of $\geq$ 100 lb/ft^3. If a coating is used that has a lower dry film density, a report must exist and conclude that the coating will not transport. A report exists and concludes that inorganic zinc coatings used on these surfaces is safety – service level I.
	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 located above the maximum flood level where there is sufficient water flow to transport this caulking, signs or tags.	A report exists and concludes that tags and signs used in these locations are made of steel or another metal with a density $\geq$ 100 lb/ft^3. 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. If a report exists and concludes that there is insufficient water flow to transport lightweight (< 100 lb/ft^3) caulking, signs or tags, testing results must be provided that demonstrate the non-transport.
	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 : Sections 6.1.2.1.2 and 6.1.2.1.5** have been amended to restrict the use of inorganic zinc coatings (other than on the inside of the containment vessel) inside containment and to require any used to be safety – service level 1.*

6.1.2.1.1 General

The AP1000 is divided into four areas with respect to the use of protective coatings. These four areas are:

- Inside containment
- Exterior surfaces of the containment vessel
- Radiologically controlled areas outside containment
- Remainder of plant

The considerations for protective coatings differ for these four areas and the coatings selection process accounts for these differing considerations. The AP1000 design considers the function of the coatings, their potential failure modes, and their requirements for maintenance. Table 6.1-2 lists different areas and surfaces inside containment and on the containment shell that have coatings, their functions, and to what extent their coatings are related to plant safety.

Coatings used outside containment do not provide functions related to plant safety except for the coating on the outside of the containment shell. The coating on the outside of the containment shell above elevation 135′ 3″ shell supports passive containment cooling system heat transfer and is classified as a Service Level III coating.

The 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 a coating. This coating is classified as a Service Level I coating.

Coatings are not used in the vicinity of the containment recirculation screens to minimize the possibility of debris clogging the screens. Subsection 6.3.2.2.7.3 defines the area in the vicinity of the recirculation screens where coatings are not used.

Coatings used inside containment, except for the containment shell, are classified as Service Level II coatings because their failure does not prevent functioning of the engineered safety features. If the Service Level II coatings delaminate, the solid debris they may form will not have a negative impact on the performance of safety-related post-accident cooling systems. See subsection 6.1.2.1.5 for a discussion of the factors including plant design features and low water flows that permit the use of Service Level II coatings inside containment. Protective coatings are maintained to provide corrosion protection for the containment pressure boundary and for other system components inside containment.

The corrosion protection of the containment shell is a safety-related function. Good housekeeping and decontamination functions of the coatings are nonsafety-related functions.

For information on coating design features, quality assurance, material and application requirements, and performance monitoring requirements, see subsection 6.1.2.1.6.

6.1.2.1.2 Inside Containment

Carbon Steel

Inorganic zinc is the basic coating applied to all of the containment vessel. Below the operating floor, most of the inorganic zinc coating is top coated with epoxy where enhanced decontamination is desired. The epoxy top coat on the containment vessel extends above the operating floor up to a wainscot height of 7 feet above the operating floor. Carbon steel and structural modules within the containment are coated with self-priming high solids epoxy (SPHSE). Where practical, miscellaneous carbon steel items (such as stairs, ceilings, gratings, ladders, railings, conduit, duct, and cable tray) are hot-dip galvanized. Steel surfaces subject to immersion during normal plant operation (such as sumps and gutters) are stainless steel or are coated with SPHSE applied directly to the carbon steel without an inorganic zinc coating. Carbon steel structures and equipment are assembled in modules and the modules are coated in the fabrication shop under controlled conditions.

Concrete

Concrete surfaces inside containment are coated primarily to prevent concrete from dusting, to protect it from chemical attack and to enhance decontaminability. In keeping with ALARA goals, the exposed concrete surfaces are made as decontaminable as practical in areas of frequent personnel access and areas subject to liquid spray, splash, spillage or immersion.

Exposed concrete surfaces inside containment are coated with an epoxy sealer to help bind the concrete surface together and reduce dust that can become contaminated and airborne. Concrete floors inside containment are coated with a self-leveling epoxy or SPHSE floor coating. Exposed concrete walls inside containment are coated to a minimum height of 7 feet with an epoxy or SPHSE applied over an epoxy surfacer that has been struck flush.

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 (density $\geq$100 lb_m/ft^3). 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 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 epoxies applied to concrete and carbon steel surfaces are sufficiently heavy (dry film density $\geq$100 lb/ft^3) so that transport with the low water velocity in the AP1000 containment is limited.

Inside containment, there are components coated with various manufacturers' standard coating systems. These coating systems are generally 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 or equal to 100 lb/ft^3) so that transport with the low water velocity in the AP1000 containment is limited. If coating debris is generated, testing and/or analysis must be performed to demonstrate that the debris is not transported to an AP1000 screen or into the core through a flooded break. The testing and/or analysis must be approved by the NRC. In addition, inorganic zinc should only be used on component surfaces that may be exposed to temperatures that are above the limits of epoxy coatings during normal operating conditions; inorganic zinc coatings used in such applications are required to be Safety – Service Level I to prevent detachment during a LOCA since such debris is not likely to settle out

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."

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Justification for changes to DCD Tier 2 : Table 6.1-2 *has been amended to restrict the use of inorganic zinc coatings inside containment (other than on the inside of the containment vessel) and to require any used to be safety – service level 1.*

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
	Shell surfaces below 7 feet above operating deck	Carbon Steel	Inorganic Zinc Coating with Epoxy Top Coat	1 Nondetachable 2 Inhibit corrosion 3 Enhance radioactive decontamination	1 Safety 2 Safety 3 Safety	Safety – Service Level I
Components Inside Containment	(6)	Material of 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	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

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	Steel walls, ceilings, floors, columns, beams, braces, plates (4)	Carbon Steel	Self-Priming High Solid Epoxy	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 wetability, 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 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. If coating debris is generated, testing and/or analysis must be performed to demonstrate that the debris is not transported to an AP1000 screen or into the core through a flooded break. The testing and/or analysis must be approved by the NRC. Inorganic zinc should only be used on surfaces that may be exposed to temperatures that are above the limits of epoxy coatings during normal operating conditions; inorganic zinc coatings used in such applications is required to be Safety – Service Level I to prevent detachment during a LOCA since such debris is not likely to settle out.
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** is amended to clarify the requirements on "suitable equivalent" insulation. The ZOI for Min-K and rigid closed cellular glass insulation is added. A requirement for a test and/or analysis report to justify the non-transport of light weight caulking, signs or tags is added. The latent debris amounts (total and fiber) are changed. An allowance is added for ZOI coating fines. The transport of debris has been clarified to specifically address fiber and particles separately. The maximum amount of fiber that can be transported into a flooded LOCA break is increased and the limiting break changed to a large cold leg (CL). The limiting screen and core flow rates are reduced to those applicable to PXS operation with the limiting amount of debris. Justification as to why this will not limit RNS operation is also provided. The dP limits with the limiting debris loads were reduced to those applicable for operation with the PXS.*

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 encapsulated in SS that is seam welded such that LOCA jet impingement does not damage the insulation and generate debris. Another suitable equivalent insulation is 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 qualify as a suitable equivalent insulation, testing must be performed that subjects the insulation to conditions that bound the AP1000 conditions and demonstrates that debris would not be generated. If debris is generated testing and/or analysis must be performed to demonstrate that the debris is not transported to an AP1000 screen or into the core through a flooded break. It would also have to be shown that the material used would not generate chemical debris. In addition, the testing and/or analysis must be approved by the NRC.

   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 distance equal to 29 inside diameters (for Min-K, Koolphen-K, or rigid cellular glass insulation) or 20 inside diameters (for other types of insulation) 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 in 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. In order to qualify as a suitable equivalent insulation, testing must be performed that subjects the insulation to conditions that bound the AP1000 conditions and demonstrates that debris would not be generated. If debris is generated testing and/or analysis must be performed to demonstrate that the debris is not transported to an AP1000 screen or into the core through a flooded break. It would also have to be shown that the material used would not generate chemical debris. In addition, the testing and/or analysis must be approved by the NRC.

   Insulation used inside containment, outside the ZOI but above the maximum post DBA accident LOCA floodup water level is 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.

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 and

    - below the maximum flood level, or

    - above the maximum flood level where there is sufficient water flow to transport caulking, signs or tags

    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. One way of demonstrating that there is insufficient water flow to transport these materials is to show that they are located inside cabinets or other enclosures; the enclosures do not have to be water tight but need to prevent dripping on them from creating a flow path that would transport the debris outside the enclosure. In order to demonstrate that light weight (< 100 lb_m/ft^3) caulking, signs or tags do not transport, testing must be performed that subjects the caulking, signs or tags to conditions that bound the AP1000 conditions and demonstrates that debris would not be transported to an AP1000 screen or into the core through a flooded break. 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 within a ZOI (for the material used) because that determines whether they are in their original geometry or have been reduced to smaller pieces. It would also have to be shown that the material used would not generate chemical debris. In addition, the testing must be approved by the NRC.

    Tags and signs in these locations are made of stainless steel or a material that has a density $\geq$100 lb_m/ft^3.

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 ≤130 pounds and the amount of the total that might be fiber to ≤6.6 pounds.
- In addition to the resident debris, the LOCA blowdown jet may impinge on coatings and generate coating debris fines, which because of their small size might not settle. The amount of coating debris fines that can be generated in the AP1000 by a LOCA jet will be limited to less than 50 pounds. In evaluating this limit, a ZOI of 4 IDs for epoxy and 5 IDs for inorganic zinc will be used
- The total resident and ZOI coating debris that are available for transport following an LOCA are ≤173.4 pounds of particulate and ≤6.6 pounds of fiber. The percentage of this debris that could be transported to the screens or to the core is:
    - Containment recirculation screens is ≤100% fiber and particles,
    - IRWST screens is ≤50% fiber and 100% particles,
    - Core (via a DVI or a cold leg LOCA break that becomes submerged) is ≤90% fiber and 100% particles.
- 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 ≤100%,
    - Core is ≤100%.
- The maximum flow rates during recirculation, consistent with the limiting head losses across the screens and core
    - CR screens is ≤827 gpm,
    - IRWST screens is ≤410 gpm,
    - Core is ≤827 gpm.

  These flows are based on operation of the PXS. If the RNS is operating the flow rates can be higher. The head losses across the screens is expected to support RNS operation because it does not have to be evaluated assuming all of the worst case safety assumptions occur at the same time since it is not a safety feature. Note that the RNS is not effective in providing RCS injection or recirculation during a DVI LOCA and no credit for its operation is taken in the PRA during such events. During non-DVI LOCAs the limiting screen head loss is reduced because both PXS recirculation lines will be operating. In addition, the screens will be designed structurally to withstand much higher flow rates and pressure losses to provide appropriate margin during PXS and RNS operation.

No chemical precipitates are expected to enter the IRWST because the primary water input to the IRWST is steam condensed on the containment vessel. However, during a DVI LOCA, recirculation can transport chemical debris through the containment recirculation screens and to the IRWST screens. As a result, 100% of the chemical debris is conservatively assumed to be transported 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 0.25 psi at these flows 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 3.5 psi at these flows is acceptable based on long term core cooling sensitivity analysis.

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 130 pounds with less than or equal to 6.6 pounds being composed of fibrous material.