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Your ref: Docket No. 52-006
Our ref: DCP/NRC2180

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Subject: AP1000 Response to Requests for Additional Information (SRP9.2.2)

Westinghouse is submitting a response to the NRC requests for additional information (RAIs) on SRP Section 9.2.2. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

A response is provided for RAI-SRP9.2.2-SBPA-01 through -12, as sent in an email from Perry Buckberg to Sam Adams dated May 6, 2008. This response completes all requests received to date for SRP Section 9.2.2.

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

Robert Sisk, Manager
Licensing and Customer Interface
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/Enclosure

1. Response to Requests for Additional Information on SRP Section 9.2.2

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ENCLOSURE 1

Response to Requests for Additional Information on SRP Section 9.2.2

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.2.2-SBPA-01
Revision: 0

Question:

TR-103 (Page 23, Item 4) indicates that the cooling medium for the turbine building closed cooling water system (TCS) heat exchangers is changed from circulating water to a generic "cooling water" that can be provided by either circulating water and/or raw water makeup to the cooling tower basin. Also, somewhat consistent with this, Tier 2 of the DCD, Revision 16, Section 10.4.5.1.2, "Power Generation Design Basis," for the circulating water system states that: "The CWS and/or makeup water from the raw water system supplies cooling water to the turbine building closed cooling water system (TCS) heat exchangers..." It is not clear if the intent is to establish a CDI item for COL applicants to address or to provide the option of using the circulating water and/or raw water makeup to the cooling tower basin instead of establishing a CDI item. While either is acceptable to the staff, the information presented in Sections 9.2.8 and 10.4.5 is inconsistent and leads to confusion. Additional information is needed to explain the intention of the proposed change, and Tier 2 of the DCD, Revision 16, Sections 9.2.8 and 10.4.5 should be revised as necessary to eliminate the inconsistency and current confusion that exists.

Westinghouse Response:

The intent of the change to the DCD wording was to provide an option for any potential COL applicant to utilize CWS cooling tower makeup water flow OR circulating water flow as the cooling water source for the TCS heat exchangers. This was not intended to be a CDI item.

Design Control Document (DCD) Revision:

Revise DCD Revision 16, Tier 2, Section 10.4.5.2.2 as follows:

10.4.5.2.2 Component Description

Circulating Water Pumps

[[The three circulating water pumps are vertical, wet pit, single-stage, mixed-flow pumps driven by electric motors. The pumps are mounted in an intake structure, which is connected to the cooling tower by a canal. The three pump discharge lines connect to a]] common header which connects to the two inlet water boxes of the condenser [[and may also supply cooling water to the TCS and condenser vacuum pump seal water heat exchangers]]. [[Each pump discharge line has a motor-operated butterfly valve located between the pump discharge and the main header. This permits isolation of one pump for maintenance and allows two-pump operation.]]

PRA Revision:

None

Technical Report (TR) Revision:

None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.2.2-SBPA-02
Revision: 0

Question:

The description that is provided in the AP1000 DCD, Section 9.2.7, does not describe the defense-in-depth and investment protection functions of the CCWS very well. However, it is clear from the ITAAC specified in Tier 1 of the DCD, Section 2.7.2, "Central Chilled Water System," the initial test program described in Tier 2 of the DCD, Section 14.2.9.2.9, "Central Chilled Water System Testing," and Table 17.4-1, "Risk-Significant SSCs Within the Scope of D-RAP," that the CCWS is important for both defense-in-depth and investment protection considerations. It is not clear why this information is not better reflected in the description that is provided for the CCWS in Tier 2 of the DCD, Section 9.2.7, and why no investment protection short-term availability controls (IPSAC) were established for this system. Additional information is needed in the AP1000 DCD to better explain the defense-in-depth and investment protection functions of the CCWS, as well as to explain why IPSAC was not warranted for this system recognizing that CCWS is relied upon to support other defense-in-depth non-safety systems that are subject to IPSAC.

Westinghouse Response:

The high capacity chilled water subsystem of the AP1000 Central Chilled Water System (VWS) does not provide chilled water for systems required to function in support of safety-related, DID or Investment Protection functions, with the exception of the chilled water supply to the Containment Cooling System (VCS). The operation of the VCS to maintain containment average air temperature $\leq 120^{\circ}$F is separately monitored and controlled under Technical Specification LCO 3.6.5, "Containment Temperature" and associated surveillance requirement SR 3.6.5.1.

The low capacity chilled water subsystem of the VWS provides chilled water to certain VAS and VBS coolers and air handling unit cooling coils that control the temperature of the Main Control Room (MCR), electrical equipment rooms, and RNS pump rooms, each of which are provided with explicit IPSAC requirements. The IPSAC requirements for these spaces and components are met in a variety of ways.

The RNS pumps are required to be operable during MODES 1, 2, and 3 for injection purposes, as well as in MODES 5 and 6 for RCS open conditions (with the RCS at low temperature). In either case, the operation of these pumps does not require the continued provision of chilled water from the VWS to the pump room coolers. Therefore, there are no applicable requirements to be placed on the low capacity chilled water system to ensure that these two sets of RNS IPSAC requirements can be met.

The IPSAC requirements for the MCR and I&C rooms B and C that are normally cooled by the low capacity chilled water system apply to the need to maintain a long-term (72 hours) shutdown condition. The IPSAC requirements applicable to maintaining the DID and Investment Protection functions for these spaces are provided by the passive heat sinks of the Main Control Room Emergency Habitability System (VES) and various pieces of equipment within the space (e.g., ancillary fans in the MCR and I&C rooms).

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.2.2-SBPA-03
Revision: 0

Question:

The description that is provided in the AP1000 DCD, Section 9.2.2, does not describe the defense-in-depth and investment protection functions of the CCS. However, it is clear from the ITAAC specified in Tier 1 of the DCD, Section 2.3.1, "Component Cooling Water System," the initial test program described in Tier 2 of the DCD, Section 14.2.9.2.5, "Component Cooling Water System Testing," Table 16.3-2, "Investment Protection Short-Term Availability Controls," as it pertains to CCS, and Table 17.4-1, "Risk-Significant SSCs Within the Scope of D-RAP," that the CCS is important for both defense-in-depth and investment protection considerations. In order to avoid confusion when completing the initial test program and to maintain clarity of the licensing basis for the CCS, this information should be reflected in the description that is provided in Tier 2 of the DCD, Section 9.2.2, in a manner similar to what was provided for the SWS in Section 9.2.1.

Westinghouse Response:

The description provided for the CCS in the DCD contains the same type and detail of information as that provided for other DID / Investment Protection Systems that are also described in this Section (e.g., SFS, SWS, VWS). The description provided for design features and operation of the CCS is similar to that provided for the SWS in this same section of the DCD.

The CCS ITAAC and test program description are similar to those provided for other non-safety systems that are also described in the DCD.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.2.2-SBPA-04
Revision: 0

Question:

Relocating the VFDs to the southern end of the turbine building places them in close proximity to the CCS pumps and heat exchangers. Failures associated with the VFDs could affect the capability of the CCS to perform its RTNSS function in accordance with the assumptions that were made in this regard. Additional information is needed to address this consideration.

Westinghouse Response:

The typical failures expected for high power electronic equipment include fires and in this case loss of cooling water from the dedicated cooling system or from the CCS which supplies cooling water to the VFD internal cooling system heat exchangers.

Fires in the Turbine Building caused specifically by a failure of VFD equipment, that disable both CCS pumps, have been addressed by the inclusion of a means to provide 600 gpm of cooling water to RNS HX A from the FPS to provide continued capability to remove decay heat from the RCS following suppression of the fire. During suppression activities, the plant passive safety systems ensure that decay heat is removed from the core and therefore cooling of the RNS heat exchangers with CCS is not required. SFS pool cooling is also provided by other means during this period of time. These provisions are described in DCD Revision 16, Tier 2, Sections 9.1.3.4.3 and 9.2.2.4.5.5.

A break in the VFD internal cooling water lines or in the CCS lines supplying the heat exchangers does not increase the risk of a flooding event, as a break of this size is enveloped by the bounding flooding case of breaks in larger CCS and SWS lines in the southern end of the Turbine Building.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.2.2-SBPA-05
Revision: 0

Question:

Westinghouse reanalyzed the fluid pressures throughout the redesigned CCS piping system and determined that the design pressure of the CCS must be increased from 1034.2 kPa (150 psig) to 1379 kPa (200 psig). However, the total design differential head of the CCS pumps is actually reduced substantially and it is not clear why the system pressure must be increased. This needs to be better explained so the staff can understand why this change is needed and determine if relief valve sizing is adequate.

Westinghouse Response:

The increase in system design pressure was based on a standard analysis methodology that defines the system design pressure on the basis of the limiting pressure obtained at the lowest point in the system, with the CCS pump assumed to be operating at its shutoff head. System hydraulic analysis also verified that the pressure will be just below the relief valve setpoint for a 150 psig design pressure system during normal operation for equipment located at low elevations.

Operating experience reports from numerous operating plants confirm that CCS relief valve actuation occurs frequently in 150 psig systems during normal system reconfigurations (e.g., pump swaps). To minimize the occurrence of frequent relief valve actuation in the AP1000 CCS, which increases the likelihood of leakage, the system design pressure was increased to 200 psig.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.2.2-SBPA-06
Revision: 0

Question:

The proposed ITAAC requires COL applicants to demonstrate that the CCS design is capable of supporting plant shutdown and spent fuel cooling. Changes are proposed for the Tier 1 ITAAC acceptance criteria that are specified in Table 2.3.1-2 to demonstrate a flow rate for each CCS pump of at least 10,164 lpm (2685 gpm) to one shutdown cooling heat exchanger (this is unchanged), 4542 lpm (1200 gpm) to one spent fuel pool heat exchanger, and at least 16,713 lpm (4415 gpm) to other CCS loads, for a total CCS flow rate for each CCS pump of 31,419 lpm (8300 gpm). Tier 2 of the DCD, Section 9.2.2, does not identify what the minimum CCS flow requirements are for these three categories of heat loads, how much excess margin is available for each one, the basis for this determination, and how the specified flow balance will be maintained over time. This information is needed in order for the staff to determine the adequacy of the specified CCS flow rate requirements, and it should be included in the AP1000 DCD as appropriate to clearly specify the plant design basis to assure it is properly maintained over time.

Westinghouse Response:

The changes proposed to Table 2.3.1-2 reflect the latest information on CCS requirements for plant shutdown and spent fuel cooling. The values provided in the table represent the minimum values of all CCS operating parameters for which the system can be expected to provide its required cooling capacity. The values of these parameters are well within the capability of the system and components as designed, and assume a substantial reduction from the initial design values to represent potential degradation of the system over time.

The UA value of 14.0 x 10^6 Btu/hr-°F represents a 10% reduction in the actual design UA of the CCS heat exchanger (15.5 x 10^6 Btu/hr-°F). The heat exchanger design case is the normal full power case, with one train of CCS and SWS operating, at 0% exceedence wet bulb ambient temperature conditions. The heat exchanger frame provided is capable of accepting at least 10% higher the number of plates than needed to provide the design UA, to allow for any future necessary increase in heat exchanger capacity. With a total CCS flow rate composed of the sum of flow rates presented for each of the three different load types, the reduced heat exchanger UA value of 14.0 x 10^6 Btu/hr-°F is sufficient to ensure that the system heat load can be transferred to the SWS, with the RCS temperature held at 350°F (safe shutdown condition). Refer to TR-111 sections 3.1, 3.3.1 and 3.3.5 for information on the requirements that led to the increase in the design capacity of the CCS heat exchanger.

Reference:
1. APP-GW-GLN-111, 'CCS and SWS Changes Required for Increased Heat Loads', TR-111

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.2.2-SBPA-07
Revision: 0

Question:

The current acceptance criterion specifies a UA value of 740×10^6 W/°C (12.1×10^6 Btu/hr-°F), and Westinghouse proposes to change this to 856×10^6 W/°C (14.0×10^6 Btu/hr-°F). Westinghouse did not identify how the proposed CCS heat exchanger UA value was determined and how much margin is available to address operational considerations, on what basis this determination is appropriate and justified, and how the specified CCS heat transfer capability will be maintained over time. This information is needed in order for the staff to determine the adequacy of the CCS heat exchanger UA value that is specified, and it should be included in the AP1000 DCD as appropriate to clearly specify the plant design basis to assure it is properly maintained over time.

Westinghouse Response:

The UA value of 14.0×10^6 Btu/hr-°F represents a 10% reduction in the actual design UA of the CCS heat exchanger (15.5×10^6 Btu/hr-°F). The heat exchanger design case is the normal full power case, with one train of CCS and SWS operating, at maximum safety non-coincident wet bulb ambient temperature conditions. This was discussed in TR-111 sections 3.1, 3.3.1, and 3.3.5.

The plate and frame heat exchanger includes additional frame length such that plates equivalent to 10% greater surface area can be added after the unit is placed in service, if additional heat transfer capability is required.

Reference:

1. APP-GW-GLN-111, 'CCS and SWS Changes Required for Increased Heat Loads', TR-111

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

RAI Response Number: RAI-SRP9.2.2-SBPA-08
Revision: 0

Question:

Tier 2 Table 9.2.2-1 includes proposed changes that have not been explained and justified. In particular, the bases for the proposed changes to the CCS pump design capacity and total differential head have not been addressed. Also, the bases for the proposed changes to the CCS heat exchanger design duty, design UA, and design flow rate (CCS side) have not been addressed. Additional information is needed in order for the staff to understand the basis for and determine the adequacy of these proposed changes.

Westinghouse Response:

The CCS pump flow rate has been increased because of the increased flow requirements of the various components cooled by the system. In particular, the cooling water flow requirements of the Reactor Coolant Pumps have increased substantially as the pump design has matured. The TDH requirement for the CCS pump was reduced substantially by increasing the diameter of several of the CCS main supply and return headers, to minimize dynamic losses in the system. This also reduced the size of the CCS pump motor and its diesel loading requirements.

The ability to reduce pump head was limited by the need to balance flow among the various parallel user pathways in the system under the various anticipated pump / heat exchanger / user operating configurations. See TR-111 sections 3.1, 3.3.1 and 3.3.5 for more discussion of this topic and for a discussion of the bases for increases in CCS heat exchanger duty and UA.

The Westinghouse response to SRP-9.2.2-SBPA-06 and SPBA-07 also provides additional information on the basis for the size (UA) increase of the CCS heat exchanger.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.2.2-SBPA-09
Revision: 0

Question:

Tier 2 of the AP1000 DCD, Section 9.2.2.1.2.1, "Normal Operation," proposes to increase the maximum allowed CCS supply temperature to plant components from 35 °C (95 °F) to 37.2 °C (99 °F) during normal plant operations, but the basis for this proposed change is not explained and justified. Additional information is needed in order for the staff to understand the basis and determine the adequacy of the proposed change.

Westinghouse Response:

The basis for the increase in the maximum CCS temperature to plant components is described in TR-108 pg. 11. The limiting value of 99°F for maximum CCS temperature stems from the increase in the maximum safety non-coincident wet bulb temperature from 81°F to 85.5°F and is consistent with SWS cold water temperature of 93.5°F supplied to the CCS heat exchangers.

In order to accommodate the Levy site environmental parameters within the AP1000 design envelope, a further increase in the value of the maximum safety non-coincident wet bulb temperature has recently been made. The revised maximum safety wet bulb temperature has now been increased to 86.1°F. The maximum normal non-coincident wet bulb temperature limit remains 80.1°F.

The AP1000 CCS heat exchanger is sized using the SWS cold water supply temperature resulting from cooling tower operation at the maximum safety non-coincident wet bulb condition, because this condition has a higher likelihood of occurring during power operation. The SWS cold water temperature is based on the predicted cooling tower approach to wet bulb (ATWB) for the SWS full power heat load. The design case assumes one train each of CCS and SWS are operating with the plant at full power. Recent information obtained from prospective cooling tower suppliers indicates that ATWB is no greater than 5.5°F for this condition at 86.1°F wet bulb. It should be noted that TR-108 used a conservative value of 8°F for the SWS cooling tower ATWB to determine the cold water temperature of 93.5°F (88.5°F + 8°F) reported in that document, which resulted in a CCS temperature of 99°F.

The maximum safety wet bulb temperature value is specified for the AP1000 in Tier 1 Table 5.0-1 and Tier 2 Table 2-1. With the increased wet bulb temperature of 86.1°F and 5.5°F ATWB, expected cold water temperature is 91.6°F. For this cold water temperature, the maximum CCS temperature will be less than 97.5°F. The new CCS maximum temperature (97.5°F) is bounded by the 99°F maximum CCS temperature previously reported in TR-108 and cited in DCD Revision 16.

Reference:

1. APP-GW-GLN-108, 'AP1000 Site Interface Temperature Limits', TR-108, Revision 2

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.2.2-SBPA-10
Revision: 0

Question:

The proposed changes to the site interface temperature limits are reflected in Tier 2 of the AP1000 DCD, Section 9.2.2, in place of the values that were previously listed. Although the values correspond to how they were used previously, the Tier 2 description does not explain why the maximum safety (noncoincident) wet bulb temperature is specified for normal operation and the maximum normal wet bulb temperature is specified for the other cases. Additional explanation is needed for why the maximum safety limit does not apply for the CCS defense-in-depth and RTNSS functions, and this should be explained in the DCD description to assure that this is the intended approach and to clearly describe what the plant design basis is in this regard.

Westinghouse Response:

The maximum safety limit non-coincident wet bulb temperature does not apply to RTNSS and Investment Protection functions because they are not functions required to guarantee the safety of the plant. DCD Revision 16, Tier 2, Sections 9.2.2.1.2.1 through 9.2.2.1.2.3 describe the wet bulb temperature condition applicable for determining the performance of the CCS heat exchangers under specific plant operating conditions.

Westinghouse has historically used the maximum safety non-coincident wet bulb temperature as a limiting value to assess the IRWST cooling case described in the DCD. The use of the highest non-coincident wet bulb temperature for this case is not required since RNS cooling of the IRWST is not a safety function; however, its use ensures that higher margins to a saturated condition can be maintained in the IRWST, thereby further reducing the likelihood of IRWST steaming to containment.

The maximum safety value is also applied in determining CCS and SWS performance for power operation since the peak ambient wet bulb temperature has a relatively high likelihood of occurrence during the operating portion of a refueling cycle. However, this maximum safety value, by definition, only persists for a limited period of time (< 2 hours per occurrence) and cannot be experienced for more than 30 hours total during any one year.

The maximum normal wet bulb temperature of 80.1°F is a more realistic value for evaluating Defense In Depth or Investment Protection cases and is used instead of the higher limiting temperature for all other cases not specifically described above.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.2.2-SBPA-11
Revision: 0

Question:

Tier 2 of the DCD, Section 9.2.2.3.5, "Piping Requirements," proposes to allow COL applicants the option of using black polyethylene piping (High Density Polyethylene or HDPE) for SWS applications in accordance with the ASME B31.1 Power Piping Code and as deemed appropriate by evaluation. Since the SWS function is considered to be risk important during shutdown conditions when the reactor is open, the impact of using HDPE on SWS reliability and availability assumptions must be considered and addressed, especially during seismic events. Also, the review criteria specified by SRP Section 3.6.1 relative to pipe failure evaluations is based on the use of metal pipe. Unless otherwise justified, the potential consequences of pipe failure (including flooding) should be evaluated assuming the complete failure of all HDPE piping during seismic events coincident with metallic pipe failures that are postulated and other considerations that are specified by the SRP. Finally, the specific criteria for allowing the use of HDPE should be reflected in the DCD to ensure clarity of the plant design basis. Additional information is needed to address these considerations, including the incorporation of design requirements in ITAAC Table 2.3.1-2 as appropriate.

Westinghouse Response:

The basis for the use of HDPE piping in the AP1000 design is described in detail in Westinghouse's response to RAI-TR103-EMB2-02. This RAI response was submitted to USNRC on February 22, 2008 under letter DCP/NRC2008.

HDPE is not used in the AP1000 CCS design nor does Westinghouse have current plans to use HDPE in this system. If HDPE were to be used for some portions of CCS piping, its use would necessarily be required to adhere to the limitations described in the Westinghouse response cited above.

Reference:
1. RAI-TR103-EMB2-02

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.2.2-SBPA-12
Revision: 0

Question:

Westinghouse proposed to change the minimum required CCS flow rate that is specified for the normal shutdown cooling heat exchanger in Tier 2 of the DCD, Table 16.3-2, "Investment Protection Short-Term Availability Controls" (IPSAC), Surveillance Requirement (SR) 2.3.1 This surveillance requirement is revised to specify that each CCS pump needs to provide at least 10,164 lpm (2685 gpm) through a normal shutdown cooling heat exchanger, which is consistent with the flow rate specified in ITAAC Table 2.3.1-2 for Design Commitment 3 (note that a change is not being proposed for the ITAAC value that was originally established). However, SR 2.3.1 previously specified a minimum flow rate of 10,675 lpm (2820 gpm), and it is not clear why the ITAAC value that was established is not the same as the value that was originally specified by SR 2.3.1 and why the ITAAC value is correct. Additional information is needed to explain this apparent inconsistency and to adequately justify the proposed change to reduce the minimum flow rate specified in IPSAC SR 2.3.1 in order for the staff to determine if the proposed change is acceptable.

Westinghouse Response:

The value of 2820 gpm is the normal CCS flow rate to each of the RNS heat exchangers and a flow rate of this value or higher is expected to be achieved with the CCS configured as required to perform the normal shutdown cooling function relating to CCS flow - one operating pump supplying one RNS heat exchanger, one SFS heat exchanger, and the remaining CCS auxiliary loads. The value of 2685 gpm in Table 2.3.1.2 of DCD Revision 16 represents the minimum required flow to accomplish the shutdown cooling and is therefore the flow that must be demonstrated in the ITAAC.

Design Control Document (DCD) Revision:
None

PRA Revision:
None

Technical Report (TR) Revision:
None