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Your ref: Docket No. 52-006
Our ref: DCP/NRC2325

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Subject: AP1000 Responses to Requests for Additional Information (SRP16)

Westinghouse is submitting responses to the NRC request for additional information (RAI) on SRP Section 16. These RAI responses are submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the responses is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Responses are provided for the following RAIs:

RAI-SRP16-CTSB-08
RAI-SRP16-CTSB-11
RAI-SRP16-CTSB-62

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
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Regulatory Affairs and Standardization

/Enclosure

1. Responses to Requests for Additional Information on SRP Section 16

D063
NRO

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ENCLOSURE 1

Responses to Requests for Additional Information on SRP Section 16

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP16-CTSB-08
Revision: 0

Question:

TS 3.4.6, Pressurizer Safety Valves.

Revise SR 3.4.6.1 and related information in TS bases B 3.4.6 to reconcile the lift setpoint requirements.

LCO 3.4.6 specifies the allowable range for OPERABILITY of the Pressurizer Safety Valves to be from 2460 psig to 2510 psig (2485 psig +/- 1%). SR 3.4.6.1 requires verification that the lift setting to be within +/- 1%. The basis for SR 3.4.6.1, however, states that "the pressurizer safety valve setpoint is +/- 3% for OPERABILITY, and the valves are reset to +/- 1% during the Surveillance to allow for drift." Also, it should be noted that the +/- 1% tolerance is based on ASME Code, Section III, NB 7500 requirements which state, in part, "the set pressure tolerance plus or minus shall not exceed the following: 2 psi (15 kPa) for pressures up to and including 70 psi (480 kPa), 3% for pressures from 70 psi (480 kPa) to 300 psi (2 MPa), 10 psi (70 kPa) for pressures over 300 psi (2 MPa) to 1,000 psi (7 MPa), and 1% for pressures over 1,000 psi (7 MPa). The set pressure tolerance shall apply unless a greater tolerance is established as permissible in the Overpressure Protection Report (NB-7200)."

Westinghouse Response:

The Bases for TS SR 3.4.6.1 will be revised to indicate +/- 1% OPERABILITY range for the Pressurizer Safety Valve lift settings, to be consistent with SR 3.4.6.1 and with the tolerance established in the AP1000 Overpressure Protection Report.

Reference 1 in the Bases for TS 3.4.6 will be revised to correctly indicate NB "7500" of the ASME Code.

Design Control Document (DCD) Revision:

See attached changes to DCD Revision 17.

PRA Revision:

None

Technical Report (TR) Revision:

None

BASES

SURVEILLANCE REQUIREMENTS

SR 3.4.6.1

SRs are specified in the Inservice Testing Program. Pressurizer safety valves are to be tested one at a time and in accordance with the requirements of ASME OM Code (Ref. 4), which provides the activities and Frequency necessary to satisfy the SRs. No additional requirements are specified.

The pressurizer safety valve setpoint is ± ~~3~~1% for OPERABILITY; ~~however,~~and the values are reset to remain within ± 1% during the Surveillance to allow for drift.

REFERENCES

1. ASME Boiler and Pressure Vessel Code, Section III, NB ~~7614.3~~7500.
2. WCAP-16779, "AP1000 Overpressure Protection Report, April 2007."
3. Chapter 15, "Accident Analyses."
4. ASME OM Code, "Code for Operation and Maintenance of Nuclear Power Plants."

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP16-CTSB-11
Revision: 0

Question:

TS 3.7.1, Main Steam Safety Valves (MSSVs). Technical Report (TR) 74C, Revision 0.

Provide additional justification for the change of tolerance from 1% to 3% for the setpoint setting of MSSVs in Table 3.7.1-2.

AP1000 DCD Revision 15 specifies a tolerance of 1%. TR 74C, Revision 0, proposed a change from 1% to 3%. The 1% tolerance was based on requirements of ASME Code, Section III, NC 7000 (Subsection NC 7512) which is listed as Reference 2 in the TS bases B 3.7.1. ASME Code Subsection NC 7512 states, in part, "The set pressure tolerance plus or minus shall not exceed the following: 2 psi (15 kPa) for pressures up to and including 70 psi (500 kPa), 3% for pressures over 70 psi (500 kPa) up to and including 300 psi (2000 kPa), 10 psi (70 kPa) for pressures over 300 psi (2000 kPa) up to and including 1000 psi (7000 kPa), and 1% for pressures over 1000 psi (7000 kPa). The set pressure tolerance shall apply unless a greater tolerance is established as permissible in the Overpressure Protection Report (NC-7200)." For justification of the proposed change, in TR 74C, Westinghouse states "Table 3.7.1-2 as-found setting was revised from 1% to 3% to be consistent with NUREG-1431 and the AP1000 Bases," however, the 3% value is bracketed in the STS, NUREG-1431, depending on conformance to ASME Code requirements discussed above.

Westinghouse Response:

Table 3.7.1-2 of TS 3.7.1 and the Bases for SR 3.7.1.1 will be revised to indicate +/- 1% OPERABILITY range for the main steam safety valve lift settings, to be consistent with SR 3.4.7.1 and with the tolerance established in the AP1000 Overpressure Protection Report.

Design Control Document (DCD) Revision:

See attached changes to DCD Revision 17.

PRA Revision:

None

Technical Report (TR) Revision:

None

MSSVs
3.7.1

Table 3.7.1-2 (page 1 of 1)
Main Steam Safety Valve Lift Settings

VALVE NUMBER		LIFT SETTING (psig ± 31%)
STEAM GENERATOR		
#1	#2	
V030A	V030B	1185
V031A	V031B	1196
V032A	V032B	1208
V033A	V033B	1219
V034A	V034B	1231
V035A	V035B	1242

BASES

SURVEILLANCE REQUIREMENTS (continued)

The ANSI/ASME standard requires that all valves be tested every 5 years and a minimum of 20% of the valves be tested every 24 months. The ASME Code specifies the activities and frequencies necessary to satisfy the requirements. Table 3.7.1-2 allows a ~~±3~~1% setpoint tolerance for OPERABILITY; ~~however,~~and the valves are reset to remain within ±1% during the Surveillance to allow for drift. The lift settings, according to Table 3.7.1-2, correspond to ambient conditions of the valve at nominal operating temperature and pressure.

This SR is modified by a Note that allows entry into and operation in MODE 3 prior to performing the SR. The MSSVs may be either bench tested or tested in situ at hot conditions using an assist device to simulate lift pressure. If the MSSVs are not tested at hot conditions, the lift setting pressure shall be corrected to ambient conditions of the valve at operating temperature and pressure.

REFERENCES

1. Chapter 10, "Steam and Power Conversion Systems Description."
2. ASME Boiler and Pressure Vessel Code, Section III, Article NC-7000, "Overpressure Protection," Class 2 Components.
3. Section 15.2, "Decreased Heat Removal by Secondary System."
4. ASME Boiler and Pressure Vessel Code, Section XI, Article IV-3500, "Inservice Test: Category C Valves."
5. ASME OM Code-1995 and Addenda through the 1996 Addenda, "Code for Operation and Maintenance of Nuclear Power Plants."
6. NRC Information Notice 94-60, "Potential Overpressurization of the Main Steam System," August 22, 1994.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP16-CTSB-62
Revision: 0

Question:

TS 3.4.8 Minimum RCS Flow

Provide justification that a total core flow rate of 3,000 gpm is acceptable and revise the applicable Bases. RAI 440.106 developed the justification for 10,000 gpm based on conservatisms applied to results based from a small-scaled test facility. (Note: SRSB agrees with RAI).

Westinghouse Response:

The intent of the discussion in the response RAI 440.106 (in approximately Fall 2003) was to provide the basis for core mixing flow rate assumptions used for current Westinghouse plants, which are applicable for the AP1000 Technical Specifications, when the bracketed items were removed.

As noted above, the SRSB agrees with the response to RAI 440.106.

At the time of the RAI, there was a bracketed (preliminary) value for the anticipated RCS core flow. The RAI response specifically clarified the basis for Westinghouse plants that 3,000 gpm of RHR flow in current plants was sufficient core mixing flow to characterize core mixing using a perfect mixing model. The intent was to provide this as the basis for replacing the bracketed flow value, since the LOFT Boron Dilution Experiment results are applicable for current Westinghouse plants and for AP1000, as indicated in the RAI response.

The bracketed items were removed from Technical Specifications via TR-74A, Revision 0 (APP-GW-GLR-064, Rev. 0, December 2006). The 3,000 gpm limit was incorporated into TS 3.4.8, as indicated in the TR markups (on page 58 of 156 pages in the submittal), based on the justification provided in RAI 440.106.

AP1000 RCS flow calculations show that the expected RCS flow with a single reactor coolant pump (RCP) operating at its lowest allowable operating speed is approximately 17,000 gpm. The associated reactor vessel flow is approximately 11,000 gpm. This is well above the 3000 gpm flow mixing requirement from the LOFT testing, and also above the preliminary bracketed value of [10,000] gpm in TS 3.4.8 prior to transmittal of TR-74A, Rev.0. The accident analysis assumptions for minimum core mixing remain valid for AP1000, satisfying the 3,000 gpm flow mixing basis.

The intent of the 3000 gpm limit provided for TS 3.4.8 in TR-74A is consistent with the flow mixing basis provided in RAI 440.106 and is not tied to the TS LCO value to a larger delivered RCP flow rate value.

The minimum flow value of 3,000 gpm value provided in TS LCO 3.4.8 provides the correct design basis value, as discussed in RAI 440.106.

The original Westinghouse response for RAI 440.106 is provided below for information (agreed with by the SRSB):

A. *NUREG-1431, Rev. 2, Technical Specifications include specific requirements for RCS flow during shutdown MODES to provide adequate heat removal and boron dilution event mixing assumptions. The minimum RCS flow requirements in these approved Technical Specification are satisfied by operation of a single RHR pump.*

   The operation of one AP1000 RCP in the specified reduced speed operation, with an RCS flow rate of at least [10,000 gpm], provides significantly greater RCS flow than the single RHR pump flow in current plants. Since AP1000 and current plants have the same boron dilution event design basis and minimum RCS flow requirements for boron mixing, the AP1000 RCS flow is significantly more than required to achieve the required boron mixing.

   The flow mixing assumptions for boron dilution analyses for both current plants and for AP1000 are based on NUREG/CR-2733, "Experimental Data Report for LOFT Boron Dilution Experiment L6-6," June 1982, conducted by Idaho National Engineering Laboratory for the U.S. NRC. This testing modeled the Trojan Nuclear Power plant design, assuming a base case RHR flow of 3000 gpm, and a second case with twice the flow of the base case. As stated in Section 3 of EGG-LOFT-5867, "Quick-Look Report on LOFT Boron Dilution Experiment L6-6," May 1982, stated that for both flow cases "the close agreement between the measurement and the core criticality value implies that the reactor vessel volume was well mixed." The Quick-Look Report abstract states that "the results of the boron dilution simulations [for both flow rates] showed that the direct flow path volume was well mixed and the boron concentration as a function of time was characterized by the perfect mixing model."

B. *The AP1000 RCPs are described in DCD Sections 5.1.3.3 and 5.4.1. The RCPs are single-stage, canned motor centrifugal pumps. A variable frequency drive provides speed control to reduce RCP speed and motor power requirements during pump startup from cold conditions below 450°F. The variable speed controller is only operated in Mode 5 with the reactor trip breakers open. During other plant conditions including power operation, the variable frequency drive is isolated from the RCP so that the RCP operates at a constant (full) speed.*

As discussed in the Bases for LCO 3.4.9 and for SR 3.4.9.1, the minimum flow requirement of [10,000 gpm] assures adequate mixing of the RCS in the event of a boron dilution event. SR 3.4.9.1 requires confirming RCS flow for the RCP combination and speed specified (one RCP operating at 25% speed), although the minimum flow is satisfied for the various pump combinations and speeds discussed in the Bases for SR 3.4.9.1.

As indicated in Table 5.4-1, the best estimate RCP design flow (during constant, full-speed operation) is 78,750 gpm per pump, or a total reactor vessel flow of 315,000 gpm with all four pumps operating. This flow can be used to calculate the pump flow at other lower operating speeds.

For a variable-speed centrifugal pump, the flow rate change is directly proportional to the pump rotational speed, and the head produced by the pump is proportional to the square of the pump speed change. Therefore, if the pump speed is reduced to the speeds indicated in the table below from Bases for Surveillance Requirement 3.4.9.1, the flow can be calculated based on the proportional change in pump speed. The table below calculates flow changes considering only changes in RCP speed, and assuming 4 RCPs continue operating. Calculating pump flow this way is conservatively low since it ignores the significant reduction in RCS system flow resistance when RCPs are stopped, and it also simplifies the approximation of RCS flow for this RAI response.

Number of RCPs	*% Rated Speed*	*Calculated Flow (gpm, based on 4 RCPs running)*
1	*25%*	*19,688 x 1 = **19,688****
2	*20%*	*15,750 x 2 = 31.500*
3	*15%*	*11,813 x 3 = 35,438*
4	*10%*	*7,875 x 4 = 31,500*

** The first RCP combination is used as the flow value for SR 3.4.9.1 since it is the normal minimum pump flow combination expected during plant cooldown prior to securing RCPs at about 160°F.*

The SR test condition provides significantly more flow than the required minimum flow for boron mixing (as discussed in Item A above) and meets the LCO requirements, even with no benefit from the reduction in RCS system flow resistance. The RCP flow provides mixing in the reactor vessel and core, the operating loop, and the idle loop.

As shown in the table above, the large RCS flow rates for the other three operating conditions discussed in the Bases for SR 3.4.9.1 significantly exceed both the boron dilution minimum flow mixing requirements and the specified LCO 3.4.9 flow requirements. These flows are also conservatively calculated without consideration of the RCS system flow resistance reduction.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None