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Your ref: Docket No. 52-006
Our ref: DCP/NRC2330

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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-09
RAI-SRP16-CTSB-63

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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/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-09
Revision: 0

Question:

TS 3.4.8, Minimum RCS Flow. Technical Report (TR) 80.

Revise LCO 3.4.8 and related information in TS bases B 3.4.8 to reflect the RNS pump operation including a justification that the affected RCS volume is well mixed under this configuration. Also, list FSAR Section 15.4.6 as a reference in the TS bases B 3.4.8.

AP1000 TS 3.4.8 is used to establish a minimum RCS flow rate through the reactor core in support of boron dilution event during plant shutdown at Mode 5. 10CFR50.36(d)(2)(ii) requires an LCO to be established for "a process variable, design feature, or operating restriction that is an initial condition of a design basis accident or transient analysis." The fifth bullet paragraph of Section 15.4.6.2.2 is being revised under TR 80 to allow for an alternate equipment lineup (e.g. using RNS pumps versus one RCP, to maintain the minimum RCS flow required in Mode 5 under TS 3.4.8. No change to TS 3.4.8 or the associated bases B 3.4.8 is being proposed to account for this alternate equipment lineup.

Westinghouse Response:

No changes are required to TS 3.4.8, TR80, or DCD 15.4.6.2.2.

Technical Specification LCO 3.4.8 establishes the minimum RCS flow rate through the reactor core during Mode 5 conditions, and the LCO correctly reflects <u>only</u> credit for core mixing flow provided by the reactor coolant pump (RCP) as the basis for boron dilution accident protection.

As noted in the Applicability statement for TS 3.4.8, this core flow requirement is applicable in Mode 5 conditions with unborated water sources <u>not</u> isolated from the RCS.

The unborated water sources will be isolated from the RCS in Mode 5 <u>prior</u> to securing the last operating RCP during the plant cooldown and can not be un-isolated until at least one RCP is operating during a plant startup.

Therefore, credit is not required for any core mixing flow provided by the normal residual heat removal system (RNS) pumps since the boron dilution event is prevented by the TS applicability statement, which is reflected in plant operating procedures.

The RNS pumps and RCP(s) operate in parallel during the RCS cooldown and heatup, until the RCPs are all secured. But prior to securing the last RCP in Mode 5 during a plant shutdown (which can be anywhere between about 160°F down to about 125°F or lower), the boron dilution water sources are isolated, and remain so throughout Mode 6 as well, as specified in TS 3.9.2.

During a plant startup / heatup, the dilution sources must remain isolated to preclude a boron dilution accident until the first RCP is started.

The RCP flow alone provides adequate mixing for a boron dilution event and is the only mixing flow source credited in safety analyses during Mode 5 conditions.

The AP1000 safety analysis text in DCD 15.4.6.2.2 includes the following bulleted item in question:

- *At least one reactor coolant pump will be normally operating during plant operation in Mode 5. It may be possible under some conditions, however, to operate the plant in Mode 5 with no reactor coolant pumps operating. For this reason, the mixing volume assumed for the analysis in Mode 5 will include the reactor coolant loop and normal residual heat removal system volumes that are being actively mixed by the residual heat removal system pumps*

The intent of the first two sentences is to indicate that under certain conditions in Mode 5 there may be no RCP operating. The RCPs are secured based on first meeting the specified TS applicability conditions by isolating dilution sources before they are stopped.

The boron dilution mixing comment in the second sentence of this bullet was intended only to identify the basis for the minimum RCS mixing volume that was considered for the safety analysis case being evaluated, as a limiting mixing volume for that sensitivity case. This is a conservative mixing volume for the purposes of the analysis and does not reflect any operating plant mixing volume with an operating RCP, which is the entire RCS water volume that is larger than the identified sensitivity case. This comment is made to define the basis for the conservative mixing volume specified in the second bullet of this same DCD subsection of 2592.5 cubic feet.

While operating in the reduced RCS inventory (mid-loop) condition specified in these two bullets with the dilution sources are isolated, RNS mixing flow is not credited in safety analyses.

With a single RCP operating at its minimum speed, the anticipated RCP flow is approximately 17,000 gpm and the core flow is approximately 11,000 gpm, which is above the 3,000-gpm minimum required core mixing flow established in the response to RAI 440.106 and discussed in the response to RAI SRP16-CTSB-62.

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-SRP16-CTSB-63
Revision: 0

Question:

TS 3.9.1 Boron Concentration

Provide an explanation for why the third paragraph of the STS Bases, Background section was not used and the reference to GDC 26 was deleted, to be consistent with the STS's.

The Bases for the STS's LCO 3.9.1 "Boron Concentration" Bases page B 3.9.1-1, the third paragraph regarding compliance with GDC discusses the necessity of the Chemical Volume and Control System as the one providing the ability to maintain the proper boron concentration. This paragraph was deleted from LCO 3.9.1 Bases page 3.9.1-1 along with the reference to GDC 26. GDC 26 was not included in the References section on Bases page 3.9.1-3.

Westinghouse Response:

Westinghouse did not include the third paragraph of the STS Bases (shown below) because of the technical differences between the standard [active] Westinghouse plant design and the passive AP1000 plant design.

> *GDC 26 of 10 CFR 50, Appendix A, requires that two independent reactivity control systems of different design principles be provided (Ref. 1). One of these systems must be capable of holding the reactor core subcritical under cold conditions. The Chemical and Volume Control System (CVCS) is the system capable of maintaining the reactor subcritical in cold conditions by maintaining the boron concentration.*

The information in the STS Bases paragraph relative to holding the reactor core subcritical under cold conditions [Mode 5 cold shutdown] is <u>not</u> applicable to the passive processes in AP1000 that satisfy the Mode 4 safe shutdown conditions for RCS temperatures between 200°F and 420°F since passive heat removal results in steam venting so that the RCS temperatures remain above 200°F. This safe shutdown condition was approved by the NRC in Subsection 7.4.1 of the AP1000 FSER (NUREG-1793), as less than 420°F.

Additionally, the AP1000 CVS [comparable to the standard plant CVCS] does <u>not</u> provide the safety-related source of borated water for these refueling water volumes. The safety-related water source for AP1000 refueling operations is the IRWST, which is already mentioned in the fourth paragraph of the Bases Background Section, so retaining a separate paragraph to indicate the IRWST is redundant.

GDC 26 of 10CFR20, Appendix A requirements for two independent reactivity control systems remains applicable for and is satisfied by the AP1000 design. Therefore, the Bases for TS 3.9.1 will be revised to include this sentence and GDC 26 will be added as Reference 3.

Design Control Document (DCD) Revision:

See attached changes to DCD Revision 17.

PRA Revision:

None

Technical Report (TR) Revision:

None

B 3.9 REFUELING OPERATIONS

B 3.9.1 Boron Concentration

BASES

BACKGROUND

The limit on the boron concentration of the Reactor Coolant System (RCS), the refueling cavity, and the transfer tube during refueling ensures that the reactor remains subcritical during MODE 6. Refueling boron concentration is the soluble boron concentration in the coolant in each of these volumes having direct access to the reactor core during refueling.

The soluble boron concentration offsets the core reactivity and is measured by chemical analysis of a representative sample of the coolant in each of the volumes. The refueling boron concentration limit is specified in the COLR. Plant procedures ensure the specified boron concentration in order to maintain an overall core reactivity of $k_{eff} \leq 0.95$ during fuel handling with control rods and fuel assemblies assumed to be in the most adverse configuration (least negative reactivity) allowed by procedures.

GDC 26 of 10 CFR 50, Appendix A, requires that two independent reactivity control systems of different design principles be provided (Ref. 3). One of these systems, the Passive Core Cooling System (PXS), is capable of holding the core subcritical under safe shutdown conditions as described in DCD Section 7.4.

The reactor is brought to shutdown conditions before beginning operations to open the reactor vessel for refueling. After the RCS is cooled down and depressurized, the vessel head is unbolted and slowly removed. The refueling cavity and the fuel transfer canal are then flooded with borated water from the In-containment Refueling Water Storage Tank (IRWST) by the use of the Spent Fuel Pool Cooling System (SFS).

During refueling, the water volumes in the RCS, the fuel transfer canal and the refueling cavity are contiguous. However, the soluble boron concentration is not necessarily the same in each volume. If additions of boron are required during refueling, the Chemical and Volume Control System (CVS) provides the borated makeup.

The pumping action of the Normal Residual Heat Removal System (RNS) in the RCS, the SFS pumps in the spent fuel pool and refueling cavity, and the natural circulation due to thermal driving heads in the reactor vessel and refueling cavity mix the added concentrated boric acid with the water in the fuel transfer canal. The RNS is in operation during refueling to provide forced circulation in the RCS, while the SFS is in operation to cool and purify the spent fuel pool and refueling cavity. Their operation assists in maintaining the boron concentration in the RCS, the refueling

BASES

ACTIONS (continued)

In determining the required combination of boration flow rate and concentration, no unique design basis accident (DBA) must be satisfied. The only requirement is to restore the boron concentration to its required value as soon as possible. In order to raise the boron concentration as soon as possible, the operator shall begin boration with the best source available for plant operations.

Once boration is initiated, it must be continued until the boron concentration is restored. The restoration time depends on the amount of boron that must be injected to reach the required concentration.

SURVEILLANCE REQUIREMENTS

SR 3.9.1.1

This SR verifies that the coolant boron concentration in the RCS, the refueling cavity and the fuel transfer canal is within the COLR limit. The boron concentration of the coolant in each volume is determined periodically by chemical analysis.

A minimum Frequency of once every 72 hours is a sufficient interval to verify the boron concentration. The surveillance interval is based on operating experience, isolation of unborated water sources in accordance with LCO 3.9.2, and the availability of the source range neutron flux monitors required by LCO 3.9.3.

REFERENCES

1. Chapter 15, "Accident Analysis."
2. NS-57.2, ANSI/ANS-57.2-1983, Section 6.4.2.2.3, American Nuclear Society, American National Standard, "Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants," 1983.
3. 10 CFR 50, Appendix A, GDC 26