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Your ref: Docket No. 52-006
Our ref: DCP/NRC2277

October 17, 2008

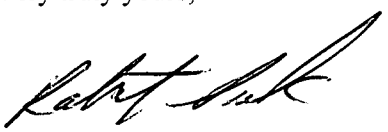
Subject: AP1000 Response to Request for Additional Information (SRP16)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 16. 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-SRP16-CTSB-03,-04,-15,-16,-19,-21 and -41 as sent in an email from S. K. Mitra to Sam Adams dated August 18, 2008 and for RAI-SRP16-CTSB-75 as sent in an email from S. K. Mitra to Sam Adams dated September 24, 2008. This response completes eight of seventy-five requests received to date for SRP Section 16.

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,



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/Enclosure

1. Response to Request for Additional Information on SRP Section 16

DO63
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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 16

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP16-CTSB-03
Revision: 0

Question:

Technical Specification (TS) Section 2.1.1, Reactor Core Safety Limits (SL), and associated Bases.

Justify the DCD Revision 16 TS SL change from Reactor Coolant System (RCS) highest loop average temperature to RCS highest loop cold leg temperature.

This change differs from previously approved AP1000 DCD TS and from the Westinghouse Standard Technical Specifications (STS), NUREG-1431. This change is not supported or consistent with bases section B 2.1.1 (Page B 2.1.1-2); still refers to highest loop average temp.

The Bases for Section 2.1.1 makes reference to the average temperature per the following:

"The figure provided in the COLR shows the loci of points of THERMAL POWER, RCS pressure, and average temperature for which the minimum DNBR is not less than the safety analysis limit."

In addition, LCO 3.4.1, "RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits," uses RCS Average Temperature as well as TR-74A Revision 2. Also, TR-74C Revision 0, SR 3.4.1.2 states: "Verify RCS average temperature is less than or equal to the limit specified in the COLR" and TR-74C Revision 0, Section B2, "Reactor Coolant System Flow Measurement," states: "TS 3.4.1 requires frequent monitoring (every 12 hours) of reactor coolant system (RCS) average temperature, pressure, and flow."

Westinghouse Response:

1. The Safety Limit change from Tavg to Tcold is associated with the change to the OTΔT and OPΔT reactor trips that protect the core against DNB and excessive kw/ft. Prior to DCD revision 16, the OTΔT and OPΔT reactor trip formulas were selected for analog equipment, requiring simple (and inexact) approximations for core limits and have remained unchanged since 1967. In DCD revision 16 the OTΔT and OPΔT functions were changed to implement new formulas that are possible due to the capabilities of the digital protection system.

The digital formulas are considered in two parts:

> More accurate and more easily monitorable ΔT power signal.
> The new formula converts ΔT to a true thermal power signal by calculating enthalpy at the measured hot and cold leg temperatures and pressure, and cold leg density at the cold leg temperature and pressure, and applying exact thermodynamic equations for thermal power (based on constant cold leg volumetric flow). Dynamic compensation is

applied to Tcold to compensate for transit times from the cold leg to the core, and independent dynamic compensation applied to Thot to compensate for the transit time from the core to the hot leg. The ΔT power signal can be directly compared with measured calorimetric reactor power.

The previous analog ΔT formulation approximates the changes in density and heat capacity by modifying the trip setpoint (including rate-of-change in Tavg), such that the ΔT signal cannot be directly compared with the measured calorimetric power.

Part of this digital formula implementation includes a Tech Spec requirement to maintain the ΔT power signal within 1% RTP of the calorimetric power (new SR 3.3.1.3 included in DCD revision 17). Monitoring that variation, and correcting when and if necessary, is very similar to the existing requirement to maintain the indicated neutron flux signal with a certain percent of the measured calorimetric power. The comparison will be a simple check done be shift operators.

Convert trip setpoint to input tables.
The present OTΔT design requires linearizing the non-linear core DNB limits. This inherently loses the "white space" between the non-linear core limits and the linear reactor trip setpoints. The use of digital technology permits the non-linear core limits to be input to the function as tables.

The total gain in DNB margin from these two improvements is conservatively estimated to be between 5% and 10% in thermal power. An additional small advantage of the change is that the DNB core limits calculated by the core designers can be directly implemented as reactor trip setpoints without conversion to Tavg and ΔT equivalents; thereby simplifying both setpoint calculation and Tech Specs (e.g., core safety limits).

Less error allowance is needed with the digital generation of the ΔT power signal, based on density and enthalpy properties of water at the measured hot leg and cold leg temperature. These non-linear functions are incorporated in the ΔT power signal rather than approximated as corrections to the setpoint based on rate of change of Tavg. Therefore, the ΔT power signal, calibrated as a percent of RTP, can be directly compared with the measured calorimetric power, and recalibrated if necessary. Therefore, all power measurement error contributors can be combined, and specified as a maximum allowable difference between the two signals, thereby reducing the error allowance.

Therefore, the Safety Limits have been changed to specify the highest loop cold leg temperature to be consistent with the new OTΔT and OPΔT digital formulas that are used protect the safety limits.

The cycle-specific SL 2.1.1 highest loop cold leg temperature core safety limits and the corresponding OTΔT and OPΔT constants and limits are based on the same methodology and specified in the COLR.

2. Bases pages B 2.1.1-2 and B 2.1.1-3 were revised to reference cold leg temperature instead of average temperature. These changes were incorporated into the AP1000 DCD Revision 16 by APP-GW-GLR-134 (Technical Report 134), Revision 0.

3. The Tavg limit specified by LCO 3.4.1 is an operating limit. This requirement is not affected by the Tcold changes to the core limits that are specified in SL 2.1.1 and protected by LCO 3.3.1.1.

Tavg is used for the normal plant control and is, therefore, appropriate for continued use as the LCO 3.4.1 operating limit.

No change to LCO 3.4.1, "RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits," is needed.

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-04
Revision: 0

Question:

TS Section 3.1.4, Rod Group Alignment Limits:

Correct the format of the DCD TS which is not consistent with the STS format. Specifically, the STS connects the LCO requirements with the word "and," while the DCD TS does not.

DCD TS should read:

"All shutdown and control rods shall be OPERABLE.
[and]
Individual indicated rod positions shall be within 12 steps of their group step counter demand position."

Westinghouse Response:

The format of LCO 3.1.4, Rod Group Alignment Limits was changed in DCD revision 17 to be consistent with the STS by the addition of "AND" between the LCO requirement statements.

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-15
Revision: 0

Question:

B3.6.6 Passive Containment Cooling System - Operating
Correct the Bases B 3.6.6 to accurately reflect Technical Specification 3.6.6. In the Bases, on page B 3.6.6-5, the description for D.1 and D.2 does not accurately reflect what is stated in Condition D. for Technical Specification 3.6.6. Condition D requires cold shutdown when the required action and associated completion times are not met or when the LCO is not met for reasons other than Conditions A, B, or C. The description for D.1 and D.2 states that the plant must go into cold shutdown when the required action and associated completion times for Conditions A or B are not met or if the LCO is not met for reasons other than Condition A or B. This description fails to include Condition C. Provide a corrected description in the Actions section that matches the requirements of Technical Specification 3.6.6.

Westinghouse Response:

The following correction to the LCO 3.6.6 Bases was made in DCD revision 17:

> D.1 and D.2
>
> If any of the Required Actions and associated Completion Times ~~for Condition A or B~~ are not met, or if the LCO is not met for reasons other than Condition A, ~~or~~ B, or C, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 84 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems. The extended interval to reach MODE 5 allows additional time and is reasonable when considering that the driving force for a release of radioactive material from the Reactor Coolant System is reduced in MODE 3.

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-16
Revision: 0

Question:

B3.6.7 Passive Containment Cooling System - Shutdown
Corret Bases B 3.6.7 to accurately reflect Technical Specification 3.6.7. In the Bases, on page B 3.6.7-2, the description for D.1.1, D.1.2, and D.2 does not accurately reflect what is stated in Condition D. for Technical Specification 3.6.7. Condition D is applicable when the required action and associated completion times are not met or when the LCO is not met for reasons other than Conditions A, B, or C. The description for D.1.1, D.1.2, and D.2 states that initiation is applicable when the required action and associated completion times for Conditions A or B are not met or if the LCO is not met for reasons other than Condition A or B. This description fails to include Condition C. Provide a corrected description in the Actions section that matches the requirements of Technical Specification 3.6.7.

Westinghouse Response:

The following correction to the LCO 3.6.7 Bases was made in DCD revision 17:

D.1.1, D.1.2, and D.2

Action must be initiated if any of the Required Actions and associated Completion Times ~~for Condition A, or B~~ are not met, or if the LCO is not met for reasons other than Condition A, ~~or~~ B, or C. If in MODE 5 with the RCS pressure boundary open and/or pressurizer level < 20%, action must be initiated, immediately, to increase the RCS level to a pressurizer level ≥ 20% and to close the RCS so that the PRHR HX operation is available. If in MODE 6, action must be initiated, immediately, to increase the refueling cavity water level ≥ 23 feet above the top of the reactor vessel flange. In both cases, the time to RCS boiling is maximized by maximizing the RCS inventory and maintaining RCS temperature as low as practical. Additionally, action to suspend positive reactivity additions is required to ensure that the SDM is maintained. Sources of positive reactivity addition include boron dilution, withdrawal of reactivity control assemblies, and excessive cooling of the RCS.

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-19
Revision: 0

Question:

LCO 3.1.8, Page 3.1.8-1:

Provide justification for going critical with an RCS lowest loop average temperature >541oF during the performance of PHYSICS TESTS initiated in MODE 2.

Per TS 3.4.2, "RCS Minimum Temperature for Criticality," the minimum temperature for criticality is Tavg >551oF. The justification may be similar to that provided in the APPLICABILITY section in B 3.4.2, page B 3.4.2-2 for MTC.

Westinghouse Response:

The AP1000 LCO 3.1.8 and 3.4.2 Bases provide the same justification for the temperature limits as are provided in the WOG STS. No additional justification is needed for AP1000.

LCO 3.1.8 Bases

The AP1000 LCO 3.1.8 Bases Applicable Safety Analysis addresses the justification for the PHYSICS TEST conditions specified and includes references to supporting information in the Westinghouse Reload Safety Evaluation Methodology report and the Chapter 14 low power PHYSICS TEST requirements. The LCO 3.1.8 Bases provide the following conclusion:

> the fuel design criteria are preserved as long as the power level is limited to ≤ 5% RTP, the reactor coolant temperature is kept ≥ 541°F, and SDM is within the limits provided in the COLR.

In addition, the SR 3.1.8.2 Bases note that compliance with the temperature limit ensures that the unit is not operating in a condition that could invalidate the safety analyses.

LCO 3.4.2 Bases

The Applicability section acknowledges that an exception to the Tavg limit is permitted by LCO 3.1.8:

> The special test exception of LCO 3.1.8, "MODE 2 PHYSICS TEST Exceptions," permits PHYSICS TESTS to be performed at ≤ 5.0% RTP with RCS loop average temperatures slightly lower than normally allowed so that fundamental nuclear characteristics of the core can be verified. In order for nuclear characteristics to be accurately measured, it may be necessary to operate outside the normal restrictions of this LCO. For example, to measure the MTC at beginning of cycle, it is necessary to allow RCS loop average temperatures to fall below $T_{no\ load}$, which may cause RCS loop average temperatures to fall below the temperature limit of this LCO.

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

The AP1000 Bases discussion of the LCO 3.1.8 and LCO 3.4.2 limits are the same as the WOG STS. No additional Bases justification of the minimum Tavg temperature limits is necessary.

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-21
Revision: 0

Question:
LCO 3.1.8; Page 3.1.8-1:

Provide the correct Function number listed in LCO 3.1.8. The incorrect Function reference appears to be the result of a change to the previously referenced Function number.

Revision 16 states:
"During the performance of PHYSICS TESTS, the requirements of ..may be suspended and the number of required channels for LCO 3.3.1, "RTS Instrumentation," Functions 2, 3, 6 and 16.c, may be reduced to 3 required channels, provided.. "

The inappropriate Function is Function 16.c (see Page 3.3.1-15). Function 16.c now relates to "Pressurizer Pressure,
P-11." The appropriate function appears to be 16.b, "Power Range Neutron Flux, P-10" based on the changes made from Revision 15 to Revision 16.

Westinghouse Response:

The following correction to LCO 3.1.8 was made in DCD revision 17:

LCO 3.1.8 During the performance of PHYSICS TESTS, the requirements of:

LCO 3.1.3 "Moderator Temperature Coefficient,"
LCO 3.1.4 "Rod Group Alignment Limits,"
LCO 3.1.5 "Shutdown Bank Insertion Limit,"
LCO 3.1.6 "Control Bank Insertion Limits," and
LCO 3.4.2 "RCS Minimum Temperature for Criticality"

may be suspended, and the number of required channels for LCO 3.3.1, "RTS Instrumentation," Functions 2, 3, 6, and 16.~~c~~b may be reduced to 3 provided:

a. RCS lowest loop average temperature is ≥ 541°F,

b. SDM is within the limits specified in the COLR, and

c. THERMAL POWER is < 5% RTP.

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

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP16-CTSB-41
Revision: 0

Question:

TS 2.1 Safety Limits (EDITORIAL)

Resolve the discrepancy in the title of Reference 5. The title of DCD Section 7.2 is not correctly stated.

For Reference 5, the correct title of DCD Section 7.2 is "Reactor Trip" and not "Reactor Trip System."

Westinghouse Response:

SL 2.1.2, Safety Limits Bases was revised in DCD Revision 17 to resolve this discrepancy.

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-75
Revision: 0

Question:

Correct the following editorial errors:

(Page 5.6-4) In the 2nd paragraph, change from "LCO 3.4.15" to "LCO 3.4.14"

(Page 5.6-5) In the last paragraph, change from "LCO 3.4.15" to "LCO 3.4.14"

Westinghouse Response:

Westinghouse believes the question should have read:

Correct the following editorial errors:

(Page 5.6-4) In the last paragraph, change from "LCO 3.4.15" to "LCO 3.4.14"

(Page 5.6-5) In the 2nd paragraph, change from "LCO 3.4.15" to "LCO 3.4.14"

These changes were made in DCD Revision 17.

Design Control Document (DCD) Revision:

None

PRA Revision:

None

Technical Report (TR) Revision:

None