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Your ref: Docket No. 52-006
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Subject: AP1000 Response to Proposed Open Item (Chapter 16)

Westinghouse is submitting a response to the NRC open item (OI) on Chapter 16. This proposed open item response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following proposed Open Item(s):

OI-SRP16-CTSB-25

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 Proposed Open Item (Chapter 16)

DO03
NRO

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ENCLOSURE 1

AP1000 Response to Proposed Open Item (Chapter 16)

AP1000 TECHNICAL REPORT REVIEW

Open Item Response

RAI Response Number: OI-SRP16-CTSB-25
Revision: 0

Question:

The applicant also proposed to change requirements specified in SR 3.4.1.4 for monitoring RCS flow, to reflect an alternate testing method to the precision heat balance (an NRC-accepted method). In RAI-SRP16-CTSB-25, the staff asked Westinghouse to provide justification for the change. In the December 2, 2008, response letter, Westinghouse provided additional details about the basis for the alternate method and also stated the following:

> The intent of the proposed Section 3.4.1 is to permit either method, whichever is demonstrated to provide less measurement uncertainty....The total uncertainty in measuring flow will depend upon analysis of the baseline flow measurements and the accuracy of the devices used to periodically measure dP caused by RCS flow. If the total uncertainty is not shown to be less than for the precision heat balance plus Delta-T method, then the alternate method would not be used.

Westinghouse also indicated that no change to the AP1000 DCD or the TS 3.4.1 and associated bases is required.

In reviewing this response, the staff noted that the alternate testing method using elbow tabs had been approved for use at the South Texas Project Electric Generating Station. A review of the current South Texas Project TS found the following descriptions for the affected SRs:

> SR 4.2.5.2 The RCS flow rate indicators shall be subjected to a channel calibration at least once per 18 months.
>
> SR 4.2.5.3 The RCS total flow rate shall be determined by precision heat balance or elbow tab dP measurements at least once per 18 months.

Based on the above, the staff believes a revision to the SR 3.4.1.4 and TS Bases 3.4.1 is needed to incorporate additional details regarding the choice of a testing method that produces better uncertainty analysis results, including a new SR for a channel calibration of the RCS flow rate indicators. The NRC staff identified this as Open Item OI-SRP16-CTSB-25.

Westinghouse Response:

The NRC comments above are considered to be resolved by the following TS changes:

1. A new surveillance (SR 3.4.1.4) has been added to LCO 3.4.1, that specifies performance of a CHANNEL CALIBRATION of the differential pressure (dP) flow

channels. A frequency of 24 months has been specified to be consistent with the refueling cycle. This change follows the South Texas SR example.

2. Old SR 3.4.1.4 (now SR 3.4.1.5) has been revised to specify that the flow rate may be measured by precision heat balance or differential pressure instrumentation to clearly specify the available testing method choices. This change is consistent with the South Texas SR example.

3. Bases discussion associated with new SR 3.4.1.4 (new CHANNEL CHECK) has been added.

4. The Background and LCO sections of the Bases have been revised to address the treatment of measurement errors and the separate COLR limits for the two different flow measurement methods – precision heat balance and differential pressure flow channels. These Bases changes incorporate and clarify details discussed in the text of the original RAI response.

It is noted that the actual instrument allowances will not be known until equipment suppliers and models are finalized for unit construction and the measurement errors will not be known until completion of the initial startup testing for the applicable unit. These allowances and errors will be included in the COLR RCS flow limits in accordance with the approved methodology (WCAP-9272-P-A).

The marked-up LCO 3.4.1 and Bases are attached.

Design Control Document (DCD) Revision:

See attached revision of LCO 3.4.1 and Bases.

PRA Revision:
None

Technical Report (TR) Revision:
None

3.4 REACTOR COOLANT SYSTEM (RCS)

3.4.1 RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits

LCO 3.4.1 RCS DNB parameters for pressurizer pressure, RCS average temperature, and RCS total flow rate shall be within the limits specified below:

a. Pressurizer Pressure is greater than or equal to the limit specified in the COLR

b. RCS Average Temperature is less than or equal to the limit specified in the COLR, and

c. RCS total flow rate ≥ 301,670 gpm and greater than or equal to the limit specified in the COLR.

APPLICABILITY: MODE 1.

- NOTE -

Pressurizer pressure limit does not apply during:

a. THERMAL POWER ramp > 5% RTP per minute, or

b. THERMAL POWER step > 10% RTP.

ACTIONS

CONDITION		REQUIRED ACTION		COMPLETION TIME
A.	One or more RCS DNB parameters not within limits.	A.1	Restore RCS DNB parameter(s) to within limit.	2 hours
B.	Required Action and associated Completion Time not met.	B.1	Be in MODE 2.	6 hours

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE	FREQUENCY
SR 3.4.1.1	Verify pressurizer pressure is greater than or equal to the limit specified in the COLR.	12 hours
SR 3.4.1.2	Verify RCS average temperature is less than or equal to the limit specified in the COLR.	12 hours
SR 3.4.1.3	Verify RCS total flow rate is ≥ 301,670 gpm and greater than or equal to the limit specified in the COLR.	12 hours
SR 3.4.1.4	Perform a CHANNEL CALIBRATION of RCS total flow rate indication (differential pressure) channels.	24 months
SR 3.4.1.5	---------- **- NOTE -** Not required to be performed until 24 hours after ≥ 90% RTP. ---------- Verify that RCS total flow rate is ≥ 301,670 gpm and greater than or equal to the limit specified in the COLR as determined by precision heat balance or RCS total flow rate indication (differential pressure) measurements.	24 months

B 3.4 REACTOR COOLANT SYSTEM (RCS)

B 3.4.1 RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits

BASES

BACKGROUND

These Bases address requirements for maintaining RCS pressure, temperature, and flow rate within the limits assumed in the safety analyses. The safety analyses (Ref. 1) of normal operating conditions and anticipated operational occurrences assume initial conditions within the normal steady state envelope of operating conditions. The limits placed on RCS pressure, temperature, and flow rate ensure that the minimum departure from nucleate boiling ratio (DNBR) will be met for each of the transients analyzed.

The RCS pressure limit is consistent with operation within the nominal operational envelope. Pressurizer pressure indications are averaged to come up with a value for comparison to the limit. A lower pressure will cause the reactor core to approach DNBR limits.

The RCS coolant average temperature limit is consistent with full power operation within the nominal operational envelope. Indications of temperature are averaged to determine a value for comparison to the limit. A higher average temperature will cause the core to approach DNB limits.

The RCS flow rate normally remains constant during an operational fuel cycle with all pumps running. The minimum RCS flow limit corresponds to that assumed for DNB analyses. At the beginning of the first fuel cycle, precision (calorimetric) flow measurements, augmented by hydraulic measurements in the reactor coolant loop and pump performance, provide a value for comparison to the limit, and to determine the calibration coefficients for future use with differential pressure measurements. The reactor coolant flow rate channels are normalized to these test measurements for 100-percent indication using these calibration coefficients and are frequently monitored to determine flow degradation. A lower RCS flow will cause the core to approach DNB limits.

Operation for significant periods of time outside these DNB limits increases the likelihood of a fuel cladding failure in a DNB limited event.

APPLICABLE SAFETY ANALYSES

The requirements of this LCO represent the initial conditions for DNB limited transients analyzed in the plant safety analyses (Ref. 1). The safety analyses have shown transients initiated within the requirements of this LCO will result in meeting the DNBR criterion. This is the acceptance limit for the RCS DNB parameters. Changes to the unit which could impact these parameters must be assessed for their impact on the DNBR criterion. The transients analyzed include loss of coolant flow events and

BASES

APPLICABLE SAFETY ANALYSES (continued)

dropped or stuck rod events. An assumption for the analysis of these events is that the core power distribution is within the limits of LCO 3.1.6, "Control Bank Insertion Limits"; LCO 3.2.3, "AXIAL FLUX DIFFERENCE (AFD)"; and LCO 3.2.4, "QUADRANT POWER TILT RATIO (QPTR)."

The pressurizer pressure limit and the RCS average temperature limit specified in the COLR correspond to analytical limits, with an allowance for steady state fluctuations and measurement errors. The RCS average temperature limit corresponds to the analytical limit with allowance for controller deadband and measurement uncertainty.

The RCS DNB parameters satisfy Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

This LCO specifies limits on the monitored process variables, pressurizer pressure, RCS average temperature, and RCS total flow rate to ensure the core operates within the limits assumed in the safety analyses. These variables are contained in the COLR to provide operating and analysis flexibility from cycle to cycle. However, the minimum RCS flow, usually based on maximum analyzed steam generator tube plugging, is retained in the TS LCO. Operating within these limits will result in meeting DNBR criterion in the event of a DNB limited transient.

~~RCS total flow rate contains a measurement error based on performing precision flow measurements and using the result to normalize the RCS flow rate indicators.~~

The COLR RCS total flow rate limit is equal to or more restrictive than the ≥ 301,670 gpm limit specified in the LCO. The COLR limit reflects the cycle-specific core design and plant conditions as well as added margin.

Separate minimum RCS total flow rate limits are specified in the COLR for measurement by precision heat balance or by differential pressure instrumentation. Different flow limits may apply for each measurement method, since the two methods have unique measurement errors and instrument allowances that are included in the COLR RCS flow rate limits.

The calibration coefficients for the differential pressure (hot leg elbow and cold leg bend) RCS total flow rate indication channels are established based on the comprehensive RCS flow measurements taken at the beginning of the first fuel cycle. These measurements include precision (calorimetric) flow, differential temperature, reactor coolant loop hydraulic tests, and pump performance. The differential pressure calibration coefficients are not expected to change during plant life. Measurement errors associated with the method used to determine the calibration coefficients are included in the differential pressure COLR RCS flow rate limit.

BASES

LCO (continued)

The numerical values for pressure, temperature, and flow rate specified in the COLR are given for the measurement location but have been adjusted for instrument error.

APPLICABILITY

In MODE 1, the limits on pressurizer pressure, RCS coolant average temperature, and RCS flow rate must be maintained during steady state plant operation in order to ensure DNBR criterion will be met in the event of an unplanned loss of forced coolant flow or other DNB-limiting transient. In all other MODES, the power level is low enough that DNB is not a concern.

A Note has been added to indicate the limit on pressurizer pressure is not applicable during short term operational transients such as a THERMAL POWER ramp increase > 5% RTP per minute or a THERMAL POWER step increase > 10% RTP. These conditions represent short term perturbations where actions to control pressure variations might be counterproductive. Also, since they represent transients initiated from power levels < 100% RTP, an increased DNBR margin exists to offset the temporary pressure variations.

The DNBR limit is provided in SL 2.1.1, "Reactor Core SLs." The conditions which define the DNBR limit are less restrictive than the limits of this LCO, but violation of a Safety Limit (SL) merits a stricter, more severe Required Action. Should a violation of this LCO occur, the operator must check whether an SL may have been exceeded.

ACTIONS

A.1

RCS pressure and RCS average temperature are controllable and measurable parameters. With one or both of these parameters not within LCO limits, action must be taken to restore parameter(s).

RCS total flow rate is not a controllable parameter and is not expected to vary during steady state operation. If the indicated RCS total flow rate is below the LCO limit, power must be reduced, as required by Required Action B.1, to restore DNB margin and eliminate the potential for violation of the accident analysis bounds.

The 2 hour Completion Time for restoration of the parameters provides sufficient time to adjust plant parameters, to determine the cause for the off normal condition, and to restore the readings within limits, and is based on plant operating experience.

BASES

ACTIONS (continued)

B.1

If Required Action A.1 is not met within the associated Completion Time, 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 2 within 6 hours. In MODE 2, the reduced power condition eliminates the potential for violation of the accident analysis bounds. The Completion Time of 6 hours is reasonable to reach the required plant conditions in an orderly manner.

SURVEILLANCE REQUIREMENTS

SR 3.4.1.1

Since Required Action A.1 allows a Completion Time of 2 hours to restore parameters that are not within limits, the 12 hour Surveillance Frequency of pressurizer pressure is sufficient to ensure the pressure can be restored to a normal operation, steady state condition following loadchanges and other expected transient operations. The 12 hour interval has been shown by operating practice to be sufficient to regularly assess for potential degradation and to verify operation is within safety analysis assumptions.

SR 3.4.1.2

Since Required Action A.1 allows a Completion Time of 2 hours to restore parameters that are not within limits, the 12 hour Surveillance Frequency for RCS average temperature is sufficient to ensure the temperature can be restored to a normal operation, steady state condition following load changes and other expected transient operations. The 12 hour Frequency has been shown by operating practice to be sufficient to regularly assess for potential degradation and to verify operation is within safety analysis assumptions.

SR 3.4.1.3

The 12 hour Surveillance Frequency for RCS total flow rate is performed using the installed differential pressure flow instrumentation. The 12 hour interval has been shown by operating practice to be sufficient to regularly assess potential degradation and to verify operation within safety analysis assumptions.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.4.1.4

A CHANNEL CALIBRATION of the RCS total flow rate indication channels is performed every 24 months, at the beginning of each fuel cycle.

CHANNEL CALIBRATION is a complete check of the instrument loop, including the sensor. The test verifies that the channel responds to a measured parameter within the necessary range and accuracy.

The Frequency is based on consistency with the refueling cycle.

SR 3.4.1.5

Measurement of RCS total flow rate by performance of precision test measurements once every 24 months, at the beginning of each fuel cycle, allows the installed RCS flow instrumentation to be normalized and verifies the actual RCS flow is greater than or equal to the minimum required RCS flow rate. These test measurements may be based on a precision heat balance, or by differential pressure measurements of static elements in the RCS piping (such as elbows) that have been calibrated by previous precision tests, or by a combination of those two methods. In all cases, the measured flow, less allowance for error, must exceed the corresponding value used in the safety analysis and specified in the COLR.

The Frequency of 24 months reflects the importance of verifying flow after a refueling outage when the core has been altered, which may have caused an alteration of flow resistance.

This SR is modified by a Note that allows entry into MODE 1, without having performed the SR, and placement of the unit in the best condition for performing the SR. The Note states that the SR is not required to be performed until after 24 hours after ≥ 90% RTP. This exception is appropriate since the heat balance requires the plant to be at a minimum of 90% RTP to obtain the stated RCS flow accuracies. The Surveillance shall be performed within 24 hours after reaching 90% RTP.

REFERENCES 1. Chapter 15, "Accident Analyses."