PROPRIETARY

Nuclear Innovation
North America LLC
122 West Way, Suite 405
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March 17, 2015
U7-C-NINA-NRC-150004
10 CFR 2.390

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

South Texas Project
Units 3 and 4
Docket No. PROJ0772
Response to Request for Additional Information

Reference:

Letter from Tom Tai to Scott Head, Request for Additional Information re: South Texas Project Nuclear Operating Company Topical Report WCAP-17137-P, "Westinghouse Stability Methodology for the ABWR", February 27, 2014 (ML14034A268)

Attached are responses to the final three RAI questions in the referenced letter. Responses to the following RAI questions are provided:

RAI 4.04-4
RAI 4.04-6
RAI 4.04-13

The responses to these RAI questions contain information proprietary to Westinghouse Electric Corporation. Since this letter contains information proprietary to Westinghouse Electric Company LLC, it is supported by an affidavit signed by Westinghouse, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b) (4) of Section 2.390 of the Commission's regulations.

Accordingly, it is respectfully requested that the information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR Section 2.390 of the Commission's regulations.

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Attachments 1 through 3 contain the proprietary responses to the RAI questions. Attachments 4 through 6 contain the non-proprietary version of the responses. Attachment 7 contains the request for withholding of proprietary information, the affidavit, the proprietary information notice, and the copyright notice.

Correspondence with respect to the copyright or proprietary aspects of this information or the supporting Westinghouse Affidavit should reference CAW-15-4113 and should be addressed to: J. A. Gresham, Manager, Regulatory Compliance, Westinghouse Electric Company LLC, 1000 Westinghouse Drive, Suite 310, Cranberry Township, Pennsylvania, 16066.

If this letter becomes separated from the proprietary material it is no longer proprietary.
If you have any questions, please contact me at (979) 316-3011, or Bill Mookhoek at (979) 316-3014.

There are no commitments in this letter.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 3/17/15

Scott Head
Manager, Regulatory Affairs
Nuclear Innovation North America LLC

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Attachments:

1. RAI 4.04-4 (Proprietary)
2. RAI 4.04-6 (Proprietary)
3. RAI 4.04-13 (Proprietary)
4. RAI 4.04-4 (Non-Proprietary)
5. RAI 4.04-6 (Non-Proprietary)
6. RAI 4.04-13 (Non-Proprietary)
7. Request for Withholding Proprietary Information

cc: w/o attachment except*
(paper copy)

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RAI 4.04-4. Treatment of Uncertainties

QUESTION:

WCAP-17137P does not seem to provide a complete documentation of the treatment of uncertainties for setpoint evaluations. Provide a summary description of the treatment of uncertainties for setpoint evaluations. Provide a summary description of the treatment of uncertainties for: (1) DIVOM slope calculation, (2) setpoint determination. Specify the statistical basis for the uncertainties provided (i.e., one-sigma, 95/95, or other).

RESPONSE:

(1) DIVOM slope calculations

The cycle-specific delta critical power ratio (CPR) over initial minimum CPR (MCPR) versus oscillation magnitude (DIVOM) slope calculations are performed in a best estimate manner. At least three exposures during the cycle (the beginning of cycle (BOC), the exposure with the highest nodal peaking factor and the exposure with the highest radial peaking factor) are analyzed. The exposures for the highest global and regional mode decay ratios are added to the calculation if they are different from the three exposures described. Since regional oscillations are unlikely to develop at the state point after a three pump trip from nine reactor internal pumps (RIP) minimum pump speed, diverging power oscillations are imposed for the 20 channels with highest radial power peaking factor. It is confirmed in the analysis that these channels cover those with the lowest MCPR.

A conservative penalty is applied to the nominal DIVOM curve in reload analyses to account for changes in radial peaking from the design calculations that might occur due to actual plant operation. The penalty is determined in the following manner:

- For the limiting channel, perform a sensitivity study using the same pressure drop boundary condition by increasing the bundle power incrementally.
- Determine the increase in DIVOM slope.
- A reasonable increase in the radial peaking factor for determining the uncertainty is [ ]^{a,c}.

This approach, considering the conservatism of the safety limit minimum critical power ratio (SLMCPR) for oscillating events and the applied uncertainty on the amplitude setpoint (S_p), give appropriate margin to prevent the power oscillations from violating the SLMCPR.

(2) Setpoint determination

The procedure to determine the maximum hot channel oscillation magnitude (HCOM) for each S_p is presented in Section 5.2.1 of WCAP-17137-P (Reference 1), and described schematically as:

- Perform POLCA-T simulations of diverging power oscillations; extract channel power and local power range monitor (LPRM) detector signals
- Combine LPRM detectors to make up oscillating power range monitor (OPRM) cell signals, determine the OPRM signal response, run signals through the period based detection algorithm (PBDA), and determine the trip time for each pair of amplitude setpoint/confirmation count (S_p/N_p) in Table 5-1 of WCAP-17137-P (post-processing)
- For this trip time, determine the maximum hot channel oscillation magnitude, ($HCOM_{max}$)

Table 5-2 of WCAP-17137-P provides an example of evaluated S_p vs HCOM for eight different core states. These cases were chosen arbitrarily to illustrate the variation in $HCOM_{max}$, and have to be extended to be valid for determining the setpoint uncertainty.

When implementing the Stability Methodology for an ABWR, a statistical method based on the 95/95 tolerance limit is applied to determine the 95/95 tolerance limit on HCOM for each S_p. The uncertainty methodology with its elements is outlined below.

The $HCOM_{max}$, as shown in Tables 5-2, 5-4 and 5-6 of WCAP-17137-P, is affected by the core state as well as different delay elements of the OPRM system. Figure 5-11 of WCAP-17137-P shows an example of the OPRM signal processing, where several LPRM signals with different phase and amplitude are filtered and averaged together to make up an OPRM cell signal. The amplitude- and phase-differences will impact the trip time and therefore the $HCOM_{max}$. The difference in amplitude and phase in the LPRM signals depends on the power distribution, which could be viewed as the integral output for the core state. $HCOM_{max}$ also depends on the void feedback (mostly impacting gain) and the fuel thermal time constant (with impact on frequency).

Furthermore, except for the core state and delay terms, the $HCOM_{max}$ will depend on the LPRM to OPRM assignment, the trip logic, and the LPRMs out of service. The LPRM to OPRM assignment and the trip logic is plant-specific and is evaluated based on current plant configuration.

The plant-specific setpoint uncertainty methodology will therefore be applied on a plant-specific basis by first creating a database with a large number of realistic core conditions relevant to the detect and suppress surveillance domain, typically corresponding to past and/or projected operation at the plant. The latter approach, using projected operation, will be applied for the first ABWR reloads. The database includes variations in the following parameters:

- Core power
- Core flow
- Exposure
- Control Rod Pattern
- Core Design
- Fuel Design

According to Reference 2, it is most conservative not to account for LPRMs being out of service, which will be verified by assigning a random variable (0 or 1) with some probability in the construction of the OPRM cells from the LPRM detector signals in the uncertainty methodology.

There are two deterministic delay elements that have an impact on the S_p vs. HCOM relationship, except from the OPRM Cell Processing discussed above:

- Trip Overshoot is included as a deterministic delay
- OPRM Trip Delay is also included as a deterministic delay

The statistical analysis is then performed, adding the random and deterministic elements to the core state database cases, and an upper bound at the 95% probability with a 95% confidence level is selected for the HCOM, for each pair of S_p/N_p.

References for RAI 4.04-4

1. WCAP-17137-P (Proprietary), WCAP-17137-NP (Non-Proprietary), "Westinghouse Stability Methodology for the ABWR," October 29, 2010.

2. NEDO-32465-A, Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications, August, 1996.

RAI 4.04-6. Bypass Void

QUESTION:

The formation of voids in the bypass during flow reduction transients may affect the LPRM calibration, which is normally performed at full power. Provide an estimate of the level of bypass voiding in ABWR during instability events. How is bypass voiding accounted for in the OPRM setpoint methodology?

RESPONSE:

The design transient for establishing the oscillation power range monitor (OPRM) set point is assumed to be a trip of three reactor internal pumps (RIPs) while operating at steady state on the maximum rod line with nine RIPs at minimum pump speed. This will be the state point with lowest core flow and highest core power possible to reach in the operating domain, and normally the least stable state point.

Calculations with POLCA-T for this state point, at three different exposures during the cycle (the same as used in the delta CPR over initial MCPR versus oscillation magnitude (DIVOM) methodology application in the Westinghouse Stability Methodology for the ABWR, WCAP-17137-P (Reference 1)), show [ ]a,c as summarized in the table ([ ]a,c) and figure ([ ]a,c) below.

[ ]a,c

[ ]a,c

POLCA-T has [ ]a,c which is used in the OPRM setpoint methodology. This is accomplished by [ ]a,c.

References for RAI 4.04-6

1. WCAP-17137-P (Proprietary), WCAP-17137-NP (Non-Proprietary), "Westinghouse Stability Methodology for the ABWR," October 29, 2010.

RAI 4.04-13. Example DIVOM Calculation

QUESTION:

Provide a well-documented example of DIVOM calculation from start to finish. Include input assumptions and plots of the intermediate and final results.

RESPONSE:

Apart from the oscillation power range monitor (OPRM) system to detect and suppress power oscillations, should they occur, the ABWR has several design features for improved thermal hydraulic stability. Among these are smaller inlet orifices, wider control rod pitch, and smaller steam separator pressure loss. The minimum pump speed line is set to prevent operation in the unstable region. This means that instability, either global or regional, is unlikely to happen within the operating domain. The delta CPR over initial MCPR versus oscillation magnitude (DIVOM) methodology currently used in operating reactors postulates regional oscillations at natural circulation and consequently the DIVOM curve is analyzed at this state point.

For the ABWR a modified DIVOM methodology is established.

Increasing the power until diverging oscillations occur is one way to capture the DIVOM curve. But since the DIVOM curve would then depend on the chosen power level and divergence ratio, it is not considered to be a robust approach. The adapted DIVOM methodology for the ABWR is instead to perform steady state calculations at the prescribed state point (reached after a trip of three reactor internal pumps (RIPs) from the maximum rod line with nine RIPs at minimum pump speed), and then to use channel calculations with imposed power oscillations, keeping the boundary conditions constant. This will give the response between channel power and channel flow, and thus Critical Power Ratio (CPR) at that state point using the actual stability properties. A sample calculation is described below, for beginning of cycle (BOC) conditions:

The state point for the DIVOM calculations, based on the three pump trip from nine pumps at minimum pump speed is chosen to be 31% core flow and the power is taken at the maximum rod line, 52%. The feedwater temperature and pressure are nominal at that state point.

Power:	52%
Core flow:	4510 kg/s (31% core flow)
Feedwater temperature:	164.1°C
Pressure:	68.68 bar
6 pumps at pump speed:	50.704 rad/s
4 pumps at pump speed:	0.0 rad/s

The pump trip is initiated from the following core conditions (BOC):

Power:	60%
Core flow:	5510 kg/s (37.9% core flow)
Feedwater Temperature:	174.8°C
Pressure:	69.18 bar
9 pumps at pump speed:	50.704 rad/s
1 pump at pump speed:	0 rad/s

A global steady state calculation is performed to establish channel boundary conditions (pressure drop, core inlet flow, bypass flow, axial power shape) for the regional case.

[ ]a,c

Calculations for [

]^a,c^.

[

]a,c

A diverging power oscillation is imposed on the channel. If the channel power oscillates during constant pressure drop, the inlet flow will start to oscillate, and it will be possible to derive a relationship between channel CPR and hot channel oscillation magnitude. This relationship is only marginally dependent on growth rate, but is sensitive to oscillation frequency. This example shows the calculations for an imposed relative power oscillation with a divergence ratio of 1.3 and resonance frequency of 0.5 Hz. The frequency for the imposed oscillation is chosen in the reload analysis to be equivalent to the global mode oscillation.

The results are shown in Figure 1 and Figure 2. The DIVOM slope is [ ]^a,c^.

[ ]a,c

Figure 1: Channel power and CPR oscillations [ ]a,c

[ ] a,c

Figure 2: DIVOM curve [ ][a,c]

References for RAI 4.04-13

1. WCAP-17137-P (Proprietary), WCAP-17137-NP (Non-Proprietary), "Westinghouse Stability Methodology for the ABWR," October 29, 2010.

CAW-15-4113
March 3, 2015

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

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COUNTY OF BUTLER:

I, James A. Gresham, am authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse), and that the averments of fact set forth in this Affidavit are true and correct to the best of my knowledge, information, and belief.

James A. Gresham, Manager
Regulatory Compliance

(1) I am Manager, Regulatory Compliance, Westinghouse Electric Company LLC (Westinghouse), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rule making proceedings, and am authorized to apply for its withholding on behalf of Westinghouse.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.390 of the Commission's regulations and in conjunction with the Westinghouse Application for Withholding Proprietary Information from Public Disclosure accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitute Westinghouse policy and provide the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of

Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(iii) There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information that is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iv) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.390, it is to be received in confidence by the Commission.

(v) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(vi) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in WEC-NINA-2015-0002 P-Enclosure: "Responses to RAIs 4.04-4, -6, and -13 for WCAP-17137-P, Revision 0, 'Westinghouse Stability Methodology for the ABWR'" (Proprietary), for submittal to the Commission, being transmitted by Nuclear Innovation North America (NINA) letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk. The proprietary information as submitted by Westinghouse is that associated with the NRC's review of the Westinghouse ABWR stability methodology in support of Westinghouse ABWR fuel products and may be used only for that purpose.

(a) This information is part of that which will enable Westinghouse to:

(i) Assist the customer in obtaining NRC review of the Westinghouse stability methodology as applied to ABWR plant designs.

(b) Further this information has substantial commercial value as follows:

(i) Westinghouse plans to sell the use of this information to its customers for purposes of plant specific ABWR stability analyses and implementation for licensing basis applications.

(ii) Its use by a competitor would improve their competitive position in the design and licensing of a similar product for ABWR stability analysis methodology.

(iii) The information requested to be withheld reveals the distinguishing aspects of a methodology which was developed by Westinghouse.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar technical evaluation and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended.

Further the deponent sayeth not.