Enclosures 1 and 4 are to be withheld from public disclosure under 10 CFR § 2.390. When separated from these enclosures, this letter is decontrolled.

TVA

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

May 13, 2011

10 CFR 50.4
10 CFR 2.390(b)(4)

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Unit 2
NRC Docket No. 50-391

Subject: Watts Bar Nuclear Plant (WBN) Unit 2 – Additional Responses to Request for Additional Information Regarding (1) Large Break Loss of Coolant Accident, (2) Steam Line Break, and (3) Miscellaneous Analysis

References:

1. NRC letter to TVA dated April 27, 2011, "Watts Bar Nuclear Plant, Unit 2 -Audit Report Of Westinghouse Documents Relating to Final Safety Analysis Report Accident Analyses (TAC NO. ME4620)
2. TVA letter to NRC dated April 1, 2011, "Watts Bar Nuclear Plant (WBN) Unit 2 – Response to Large Break Loca (LBLOCA) and Over-Pressurization Request for Additional Information"
3. TVA letter to NRC dated April 29, 2011, "Watts Bar Nuclear Plant (WBN) Unit 2 – Response to Requests for Additional Information (RAIs) Regarding Inadvertent ECCS Actuation Analysis, And Chemical & Volume Control System Malfunction Analysis"

The purpose of this letter is to provide additional responses to requests for additional information (RAIs) regarding (1) large break loss of coolant accident (LBLOCA), (2) Steam Line Break (SLB), and (3) miscellaneous analysis. These RAIs were received during the NRC Audit at the Westinghouse Electric Company LLC offices in Rockville, Maryland, held during the week of March 14, 2011. The results of this NRC Audit were clarified in the Audit Report issued April 27, 2011 (Reference 1). Partial responses to these RAIs were provided in References 2 and 3.

Enclosure 1 to this letter addresses the remaining LBLOCA questions (in addition to those provided in Reference 2) by providing Westinghouse document WBT-D-3108 P-Attachment, "Watts Bar 2 (WBT) Responses to remaining RAI from NRC Staff Audit Report" (Proprietary).

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NRR

This document contains information proprietary to Westinghouse. Accordingly, TVA respectfully requests that this proprietary information be withheld from public disclosure in accordance with 10 CFR 2.390. Enclosure 2 provides the supporting 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. U.S. Nuclear Regulatory Commission correspondence with respect to the copyright or proprietary aspects of the items listed above or the supporting Westinghouse affidavit should reference CAW-11-3149 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance, Westinghouse Electric Company LLC, Suite 428, 1000 Westinghouse Drive, Cranberry Township, Pennsylvania 16066.

Enclosure 3 provides Westinghouse document WBT-D-3108 NP-Attachment, " Watts Bar 2 (WBT) Responses to remaining RAI from NRC Staff Audit Report" (Non-Proprietary), containing non-proprietary version of the information provided in Enclosure 1.

Enclosure 4 to this letter provides the response to the SLB Analysis portion of the RAIs by providing Westinghouse document WBT-D-3041 P-Attachment, "Response to March 15, 2011 NRC Audit Questions on Steam Line Break Analysis for Watts Bar Unit 2" (Proprietary).

This document contains information proprietary to Westinghouse. Accordingly, TVA respectfully requests that this proprietary information be withheld from public disclosure in accordance with 10 CFR 2.390. Enclosure 5 provides the supporting 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. U.S. Nuclear Regulatory Commission correspondence with respect to the copyright or proprietary aspects of the items listed above or the supporting Westinghouse affidavit should reference CAW-11-3136 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance, Westinghouse Electric Company LLC, Suite 428, 1000 Westinghouse Drive, Cranberry Township, Pennsylvania 16066.

Enclosure 6 provides Westinghouse document WBT-D-3041 NP-Attachment, "Response to March 15, 2011 NRC Audit Questions on Steam Line Break Analysis for Watts Bar Unit 2" (Non-Proprietary). This document contains the non-proprietary version of the information provided in Enclosure 4.

In addition to the clarifying information provided in Enclosure 4, the following non-proprietary information from Westinghouse is included to explain why the SLB analysis for WBN Units 1 and 2 predicts peak post trip power levels that are less than half the peak post trip power levels predicted for other Westinghouse supplied four loop plants for the same break size:

There are many factors that influence the peak heat flux in a steamline break analysis initiated from hot zero power conditions. Watts Bar has integral flow restrictors which reduce the maximum break size compared to some other 4-loop plants and Safety Injection (SI) capacity which is favorable compared to some plants. The Watts Bar analysis models a minimum shutdown margin of 1.6% and many other plants have reduced their minimum shutdown margin to 1.3%. The maximum auxiliary feedwater assumption for Watts Bar is smaller than most other 4-loop plants. Reactivity feedback also highly influences the peak heat flux reached.

To be more specific, a comparison was made to two other Westinghouse designed 4-loop plants. The peak heat flux of the first plant is 15% and the peak heat flux for Watts Bar is just over 3%. The safety injection capacity of this other plant is roughly half that modeled for Watts Bar and the minimum shutdown margin modeled is 1.3%. Also, the maximum AFW is about twice the maximum AFW modeled for Watts Bar. Like Watts Bar, the analysis was done with the LOFTRAN computer code. As a result, the significantly higher peak heat flux for this plant when compared to Watts Bar is expected.

The licensing basis steam line break analysis for a second Westinghouse 4-100p plant was also examined. This plant has a 1.6% SDM and auxiliary feed water which is slightly less than Watts Bar. Also, the safety injection flow rates are smaller than the flow rates assumed in the Watts Bar steamline break analysis. The analysis for this plant was performed using the RETRAN code and the peak heat flux is 6.5%. The higher peak heat flux for this plant when compared to Watts Bar is expected.

Based on these two examples, the WBN peak heat flux reached is reasonable.

Enclosure 7 includes additional information regarding SLB analysis as provided in Westinghouse document WBT-D-3146 Attachment, "Watts Bar Unit 2 Steam Line Break NRC Audit Response" (non-proprietary).

Reference 1 also requested an analysis of a bottom mounted instrument (BMI) tube failure. A response to this request will be provided in conjunction with the RAIs recently received on the Mass Addition events.

There are no new commitments made in this submittal. If you have any questions, please contact Bill Crouch at (423) 365-2004.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 13th day of May, 2011.

Respectfully,

David Stinson
Watts Bar Unit 2 Vice President

Enclosures:

1. Westinghouse Document WBT-D-3108 P-Attachment, "Watts Bar 2 (WBT) Responses to Remaining RAI from NRC Staff Audit Report" (Proprietary)
2. Watts Bar Nuclear Plant Unit 2 Affidavit for Withholding Proprietary Information from Public Disclosure
3. Westinghouse Document WBT-D-3108 NP-Attachment, "Watts Bar 2 (WBT) Responses to Remaining RAI from NRC Staff Audit Report" (Non-Proprietary)
4. Westinghouse Document WBT-D-3041 P-Attachment, "Response to March 15, 2011 NRC Audit Questions On Steam Line Break Analysis for Watts Bar Unit 2" (Proprietary)
5. Watts Bar Nuclear Plant Unit 2 Affidavit for Withholding Proprietary Information from Public Disclosure
6. Westinghouse Document WBT-D-3041 NP-Attachment, "Response to March 15, 2011 NRC Audit Questions On Steam Line Break Analysis for Watts Bar Unit 2" (Non-Proprietary)
7. Westinghouse Document WBT-D-3146 Attachment, "Watts Bar Unit 2 Steam Line Break NRC Audit Response" (Non-Proprietary)

cc (Enclosures):

U. S. Nuclear Regulatory Commission
Region II
Marquis One Tower
245 Peachtree Center Ave., NE Suite 1200
Atlanta, Georgia 30303-1257

NRC Resident Inspector Unit 2
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Enclosure 2
TVA Letter Dated May 13, 2011
Additional Responses to Request for Additional Information Regarding (1) LBLOCA, (2) Steam Line Break (SLB), and (3) Miscellaneous Analysis

Watts Bar Nuclear Plant Unit 2 Affidavit for Withholding Proprietary Information from Public Disclosure

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF BUTLER:

Before me, the undersigned authority, personally appeared J. A. Gresham, who, being by me duly sworn according to law, deposes and says that he is 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 his knowledge, information, and belief:

J. A. Gresham, Manager
Regulatory Compliance

Sworn to and subscribed before me
this 2nd day of May 2011

Notary Public

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Cynthia Olesky, Notary Public
Manor Boro, Westmoreland County
My Commission Expires July 16, 2014
Member, Pennsylvania Association of Notaries

(1) I am Manager, Regulatory Compliance, in Nuclear Services, 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 constitutes Westinghouse policy and provides 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.

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.

(iii) 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.

(iv) 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.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in "Watts Bar 2 (WBT) Responses to Remaining RAI from NRC Staff Audit Report" (Proprietary), for submittal to the Commission, being transmitted by Tennessee Valley Authority 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 review of the Watts Bar Unit 2 license application.

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

(a) Assist the customer in obtaining NRC review of the Watts Bar Unit 2 license.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of this information to its customers for purposes of plant specific LOCA analysis for licensing basis applications.

(b) Its use by a competitor would improve their competitive position in the design and licensing of a similar product for LBLOCA analyses.

(c) 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 calculations 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.

Proprietary Information Notice

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.390 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.390(b)(1).

Copyright Notice

Enclosure 3
TVA Letter Dated May 13, 2011
Additional Responses to Request for Additional Information Regarding (1) LBLOCA, (2) Steam Line Break (SLB), and (3) Miscellaneous Analysis

Westinghouse Document WBT-D-3108 NP-Attachment, "Watts Bar 2 (WBT) Responses to Remaining RAI from NRC Staff Audit Report" (Non-Proprietary)

Watts Bar 2 (WBT) Responses to Remaining RAI from NRC Staff Audit Report

Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, Pennsylvania 16066

RAI 1: Provide the refueling water storage tank (RWST) temperature.

The RWST temperature range applied in the ASTRUM analysis is based on the Technical Specifications (60-105°F). [ ]a,c The limiting Peak Cladding Temperature (PCT) and Maximum Local Oxidation (MLO) case from the ASTRUM analysis (presented in the FSAR) sampled a RWST temperature of 78.1°F.

RAI 2: An explanation of how condensation was treated in this event was requested and whether condensation maximized?

Validation and treatment of Emergency Core Cooling System (ECCS) condensation in Westinghouse Best-Estimate LOCA methodologies is discussed in detail in Section 15-3 and Section 25-9 of WCAP-12945-P-A (Reference 1). [ ]a,c

ECCS condensation is not maximized, [ ]a,c

The subcooling in various regions of the downcomer for the Watts Bar 2 limiting PCT/MLO case is inspected during the period of downcomer boiling (and corresponding cladding heatup), which occurs from about 100 seconds to 280 seconds (Figures 1 and 2). [ ]a,c

[ ]a,c

RAI 3: The effect of time step on the results was also required and whether this included time steps down to and including 0.001 sec.

WCOBRA/TRAC timestep studies were documented in Section 22-5 of WCAP-12945-P-A, with the final timestep limits for PWR calculations provided in Table 22-5-4. The timestep sizes used in the Watts Bar Unit 2 ASTRUM analysis are in compliance with the limits provided Table 22-5-4. Therefore, the usage condition in the USNRC Safety Evaluation Report (SER) for WCAP-12945-P-A was met. It is noted that

Section 13-3-1 of WCAP-16009-P-A states that the timestep usage condition remains applicable with ASTRUM. As such, no plant specific timestep studies have been performed.

RAI 4: Confirm correct conductivity in the downcomer walls.

The conductivity in the downcomer walls has been confirmed. The vessel wall is modeled using carbon steel with a stainless steel cladding, and the core barrel and neutron pads are modeled using stainless steel. The conductivity of each material modeled in WCOBRA/TRAC as a function of temperature is shown in Table 1 and Table 2.

Table 1: Stainless Steel Conductivity Modeled in WCOBRA/TRAC

a,c

Table 2: Carbon Steel Conductivity Modeled in WCOBRA/TRAC

a,c

RAI 5: Confirm the values for the lateral k-factors in the downcomer (were they based on Idlechik?).

Responses to similar questions recently transmitted to the USNRC for D.C. Cook Unit 2 are generally also applicable to Watts Bar Unit 2. Information regarding how the lateral k-factors are modeled in the downcomer and comparisons to Idel'chik calculations on a plant specific basis are provided therein. [

]^{a,c} Base on the physical nature of this argument, similar conclusions can be drawn for Watts Bar Unit 2.

References:

1. Bajorek, S. M., et al., March 1998, "Code Qualification Document for Best Estimate LOCA Analysis," Volume 1 Revision 2, and Volumes 2 through 5, Revision 1, WCAP-12945-P-A (Proprietary).
2. Nissley, M. E., et al., January 2005, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment of Uncertainty Method (ASTRUM)," WCAP-16009-P-A (Proprietary).

Figure 1: Peak Clad Temperature

a,c

Figure 2: Vessel Fluid Inventory

a,c

[ ]

Figure 3: Average Liquid Subcooling in the Downcomer at the Nozzle Elevation

a,c

Figure 4: Average Liquid Subcooling in the Downcomer at Vessel Section 5

a,c

Figure 5: Average Liquid Subcooling in the Downcomer at Vessel Section 4

a,c

Figure 6: Average Liquid Subcooling in the Downcomer at Vessel Section 3 (Mid-Core)

a,c

Figure 7: Watts Bar 2 Vessel Noding Diagram

a,c

Enclosure 5
TVA Letter Dated May 13, 2011
Additional Responses to Request for Additional Information Regarding (1) LBLOCA, (2) Steam Line Break (SLB), and (3) Miscellaneous Analysis

Watts Bar Nuclear Plant Unit 2 Affidavit for Withholding Proprietary Information from Public Disclosure

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

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J. A. Gresham

J. A. Gresham, Manager
Regulatory Compliance

Sworn to and subscribed before me
this 8th day of April 2011

Cynthia Olesky
Notary Public

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Cynthia Olesky, Notary Public
Manor Boro, Westmoreland County
My Commission Expires July 16, 2014
Member, Pennsylvania Association of Notaries

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(b) Its use by a competitor would improve their competitive position in the design and licensing of a similar product for SLB analyses.

(c) 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 calculations 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.

Proprietary Information Notice

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Copyright Notice

Enclosure 6
TVA Letter Dated May 13, 2011
Additional Responses to Request for Additional Information Regarding (1) LBLOCA, (2) Steam Line Break (SLB), and (3) Miscellaneous Analysis

Westinghouse Document WBT-D-3041 NP-Attachment, "Response to March 15, 2011 NRC Audit Questions On Steam Line Break Analysis for Watts Bar Unit 2" (Non-Proprietary)

Response to March 15, 2011 NRC Audit Questions on Steam Line Break Analysis for Watts Bar Unit 2

Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, Pennsylvania 16066

Discussion of the Non-Limiting Nature of the Low Flow (i.e., Without Offsite Power) Hot Zero Power (HZP) Steam Line Break (SLB) Case

Results from two HZP SLB transient analysis cases are presented in Safety Analysis Reports (SARs) – one case assumes that offsite power is available and thus the reactor coolant pumps (RCPs) continue to operate (full flow), while the second case assumes that offsite power is lost and the RCPs coast down as a result (low flow). Both transient cases assume the same conservative end-of-life reactivity feedback coefficients, calculated for a full core flow condition and the presence of one rod cluster control assembly stuck fully out of the core. Of these two scenarios, the full flow case has generically been determined to be limiting. For this limiting case, transient statepoints based on the point kinetics model (LOFTRAN or RETRAN code) are confirmed with the detailed 3-dimensional (3D) core model (ANC code) to ensure that the reactivity model in the transient analysis provides a response close to the 3D model. The departure from nucleate boiling (DNB) evaluation is performed for this case. The non-limiting low flow case presents representative transient plots in the SAR, however, due to the generic determination that this case is not limiting, no explicit verification of the reactivity model is done and no DNB calculations are performed.

A question regarding the non-limiting nature of the low flow HZP SLB case was addressed in the licensing of the SLB topical report; see the U.S. Nuclear Regulatory Commission (NRC) Question 222.11 and Westinghouse response (WCAP-9226-P-A, Rev. 1, Section D). The response notes that the closed channel core model (no cross flow between channels) is appropriate for the full reactor coolant flow (i.e., with-power) case. The response further identified that using an open channel coupled-code (TURTLE+THINC, where cross flow between channels is modeled) was necessary for proper evaluation of the low flow case and that the low flow case DNB limit ratio (DNBR) is bounded by the full flow case.

The moderator density coefficients used in the HZP SLB transient analysis for the low flow case are overly conservative during the return-to-power phase. Furthermore, the use of an open-channel model is necessary to properly account for the effect of increased flow in the hot channel due to the phenomenon of "thermal siphoning," also termed the "chimney effect." Under low flow natural circulation conditions there would be significant cross flow from the surrounding core region into the hot channel. Flow increases by a factor of 4 or 5 from the channel inlet to the core outlet have been observed. Currently, the open channel coupled analysis would be performed with ANC and VIPRE rather than the coupled TURTLE+THINC analysis described in the WCAP-9226 RAI response. The open channel model would result in a more representative moderator density coefficient.

In the low flow case, all power is generated in a small area of the core. The reduction in flow causes a rapid increase in enthalpy rise in the high powered assembly and a corresponding large density reduction with increasing core height. This shifts the axial offset to a more negative value, which is an additional DNB benefit.

The advanced 3D transient methodology topical report (WCAP-16259-P-A, *Westinghouse Methodology for Application of 3-D Transient Neutronics to Non-LOCA Accident Analysis*, August 2006) included a sensitivity case that was performed assuming a loss of offsite power 3 seconds after the time of the reactor trip and break initiation. The loss of offsite power causes a loss of power to the RCPs, resulting in a flow coastdown. The reactor coolant system (RCS) flow during the event then depends on natural circulation to remove the core heat. The reduced flow, however, greatly reduces the ability of the secondary side to extract heat from the RCS, resulting in a much slower RCS cooldown and a reduced core return to power level. [

]^{a,c}

Another demonstration of the non-limiting nature of the HZP SLB low flow case was published in the American Nuclear Society (ANS) Nuclear Technology Journal in December of 1995; see Morita, T., et al., *Subchannel Thermal-Hydraulic Analysis at AP600 Low-Flow Steam-Line-Break Conditions*, November 1994.

In summary, the with- and without-offsite power HZP SLB transient analyses are performed using the same reactivity feedback coefficients for illustrative purposes in the SAR. The "stuck rod" point kinetics reactivity model used in these calculations is confirmed to be conservative for the limiting with-power (full flow) case using detailed 3D core models. Detailed open channel coupled-code analyses have confirmed the conclusion of WCAP-9226-P-A that the without-offsite-power (low flow) case is non-limiting.

Watts Bar Unit 2 (WBT) Response to Request for Additional Information (RAI) – Reactivity Coefficient History Information for Transmittal to NRC

Request for supporting information: For the Watts Bar hypothetical steam line break analysis, provide a discussion of reactivity coefficient changes, why the changes were made, and what was the justification.

Response:

From a core neutronics perspective, the Watts Bar Unit 2 steam line break analyses reflect the core parameter values implemented in the Watts Bar Unit 1 analyses prior to replacement steam generators (these core parameter values continue to remain applicable for Watts Bar Unit 1). Of key importance is the reactivity coefficient related to the moderator density (MDC) feedback since it provides the primary neutronics-related feedback to the steam line break transient. The historical changes reflected in the Unit 1 analyses are discussed and summarized below.

The earliest source of the MDC values (circa 1974) that eventually lead to those used in Watts Bar (both units at the time) can be traced to those used generically to support reference safety analyses of Westinghouse four loop plants. Generic values of the neutronic parameters were used as a matter of process, reflecting the fact that core designs and requirements at the time exhibited limited variability (the plant-specific safety analyses would, however, reflect differences in plant designs and requirements). The values were set based on results from core neutronics models. Additionally, the values were set to be sufficiently conservative in order to cover a class of plants (i.e., four loop) and the expected changes in future cycle-designs. In the context used here, conservatism means that the reference safety analysis would result in a higher return to power.

It is important to note that regardless of the parameter values used, Westinghouse confirmed (and continues to confirm) the conservatism of the safety analysis reactivity feedback and other criteria (i.e., DNBR) for each of the individual plant specific cycle-designs (Reference 1).

In order to address evolving design requirements and process enhancements, some of the excess conservatism was removed in the original generic parameter values. This was accomplished by a simple algebraic adjustment to the MDC, reducing the overall functional values by [ ]^{a,c}. The adequacy of the remaining conservatism was confirmed utilizing the experience base of the core neutronic models at the time.

These reduced MDC values correspond to Watts Bar analyses performed in the 1985 timeframe. The analyses were performed to support boron injection tank (BIT) removal. The peak return to power in the reference safety analyses was [ ]^{a,c}. Neutronics calculations confirmed the overall conservatism of the reactivity feedback; thermal-hydraulics calculations confirmed that DNBR limits were met.

These Watts Bar analyses were followed by analyses performed to support upper head injection elimination (1986 timeframe). The MDC values underwent another simple algebraic adjustment to the MDC, reducing the overall functional values by [ ]^{a,c}. The exact reason behind this change is not readily available from the existing documentation, other than it being identified during the iterative approach used by the multiple functions (nuclear, thermal-hydraulic, and transient) to finalize the reference safety analysis. The peak return to power in the reference safety analyses was [ ]^{a,c}. Neutronics calculations confirmed the overall conservatism of the reactivity feedback; thermal-hydraulics calculations confirmed that DNBR limits were met.

The preceding analyses predate the initial Unit 1 criticality (circa 1996). Shortly after initial criticality, a program was commenced that included numerous Watts Bar Unit 1 design and analyses updates, targeted for incorporation into the Cycle 2 design (Reference 2). This included reanalysis of the steam line break event (primarily performed for increased tube plugging limit). An updated MDC function was deemed appropriate given the multiple changes and not just increased tube plugging (since this, in and of itself, has limited neutronics impact). The peak return to power in the reference safety analyses was [ ]^{a,c}. Neutronics calculations confirmed the overall conservatism of the reactivity feedback; thermal-hydraulics calculations confirmed that DNBR limits were met.

In generating the updated MDC function, numerous core calculations were performed over a range of moderator densities [ ]^{a,c} and boron [ ]^{a,c}. The reactivity state (or eigenvalue) was determined for each of these calculations. These calculations were repeated with multiple stuck rods. A representative Unit 1 cycle design was used (the previous generic values had considered multiple plants and cycles, thus a differentiating feature of the amount of conservatism). The individual reactivity results were processed to obtain the final MDC functional values. The processing is [

]^{a,c}. While a single representative cycle design was used (there was limited Unit 1 design experience at the time), the conservatism of the safety analysis reactivity feedback (and other criteria) continued to be confirmed for Unit 1, and will be continue to be confirmed for Unit 1 and Unit 2, on a cycle-specific basis.

The preceding discussions illustrate a number of historical techniques that have been used to update the MDC values for updates to the reference safety analyses. Common to all, and part of current practice (including plant uprates), is to first evaluate the need to update these (and other) core-related inputs to the reference safety analysis. The two primary considerations in this evaluation are the availability of margins for the applicable criteria, and the number and complexity of the changes being implemented by the program. In the case of Watts Bar Unit 2, no change in the MDC parameter (relative to Unit 1) was deemed warranted, due to the similarity to Unit 1 and since Unit 1 had historically met all applicable criteria. In situations where significant changes are being made (such as the 1986 Unit 1 analyses), existing plant and cycle experience is used to guide the selection of MDC parameter values. This may even include examining a wide variety of possible future cycles (such as a significant plant uprate, for which other plant, design, and analyses changes are being considered). In all situations, cycle-specific neutronics calculations will be used to confirm the overall conservatism of the reactivity feedback and thermal-hydraulics calculations will be used to confirm that DNBR limits were met.

Additional confirmation of the safety analysis reactivity inputs is provided by the surveillance of the most negative moderator temperature coefficient (MTC) performed near end-of-cycle (EOC). The specific surveillance (Technical Specification Bases B 3.1.4 and Reporting Requirements 5.9.5) ensures that the most negative MTC at EOC remains within the bounds of the safety analyses for those transients and accidents for which the analysis results are made more severe by assuming maximum moderator feedback. MTC is a parameter which can be determined from measurement of plant conditions while the parameter actually used in safety analyses calculations is the related MDC. The surveillance explicitly confirms the [ ]^{a,c} used in selected safety analyses and implicitly confirms [ ]^{a,c} is not allowed by Technical Specifications.

Finally, summarizing supporting information cited at the March 15, 2011 audit meeting held at the Westinghouse Rockville offices, additional information regarding the treatment of reactivity coefficients used in reference safety analyses can be found in References 1 (Sections 2.4, 3.3.1, 3.3.3.5) and 3 (Sections 1.2.2, 2.2.2.1, 2.3, 3.1.1.7, and RAIs 222.4, 232.1, 232.2, 232.3).

References:

1. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology Report," July 1985.
2. TVA to NRC letter dated March 27, 1997, "Watts Bar Nuclear - Proposed License Amendment - Cycle 2 Reload Changes - Technical Specification Change No. 96-013."
3. WCAP-9226-P-A, Rev. 1, "Reactor Core Response to Excessive Secondary Steam Releases," February 1998.

Enclosure 7
TVA Letter Dated May 13, 2011
Additional Responses to Request for Additional Information Regarding (1) LBLOCA, (2) Steam Line Break (SLB), and (3) Miscellaneous Analysis

Westinghouse Document WBT-D-3146 Attachment,
"Watts Bar Unit 2 Steam Line Break NRC Audit Response"
(Non-Proprietary)

Watts Bar Unit 2 Steam Line Break NRC Audit Response

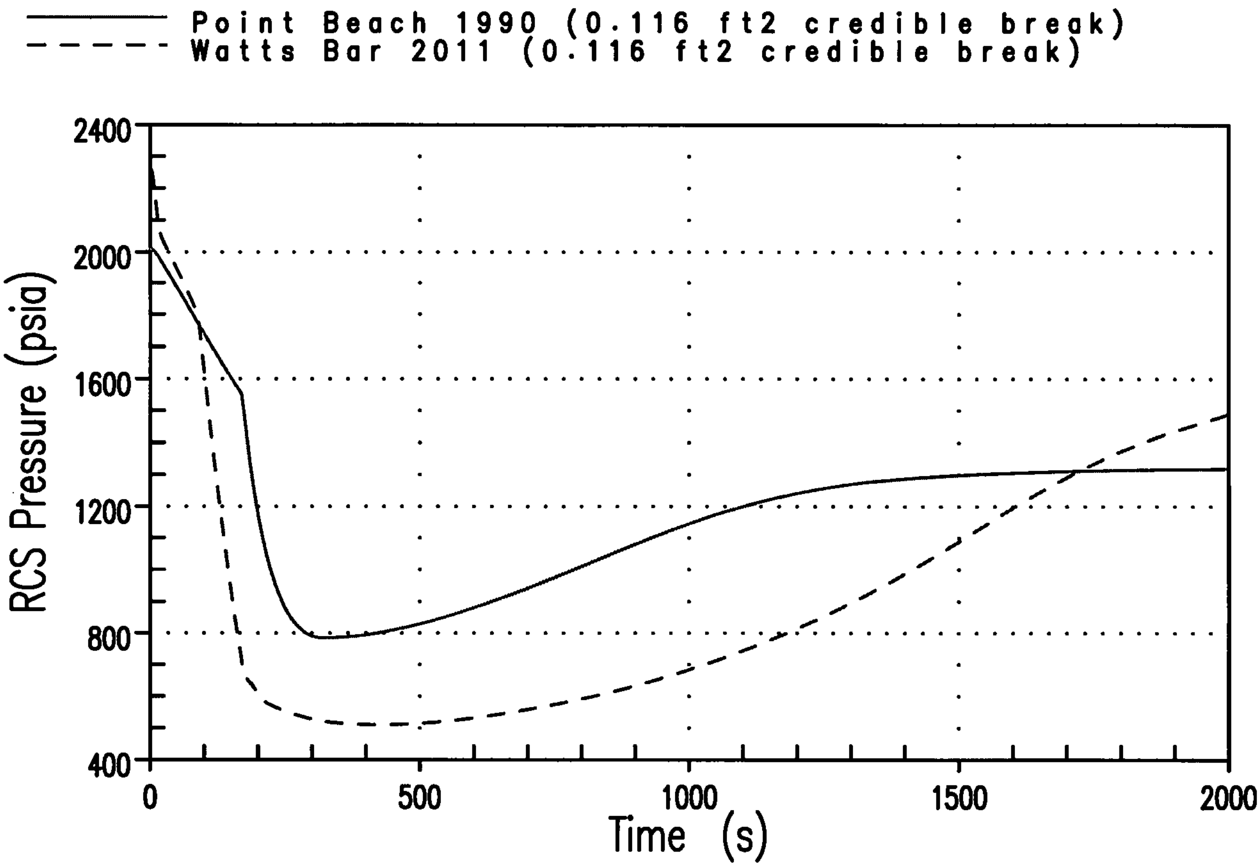
The March NRC audit of Westinghouse safety analyses in support of Tennessee Valley Authority's application for an operating license for Watts Bar Unit 2 included discussion of the hot zero power steam line break analyses. The following information pertains to this discussion from the NRC audit report.

In the Westinghouse steam line break methodology, analysis assumptions are made to maximize the RCS cooldown and subsequently maximize the reactivity feedback and the return to power. This includes maximum moderator density coefficients, maximum auxiliary feedwater, minimum safety injection and zero decay heat. Numerous analyses over the years have led Westinghouse to the conclusion that the most limiting hot zero power steam line break case is the large double-ended rupture (DER). The limiting Watts Bar steam line break analysis results in a depressurization of the RCS to the accumulator actuation pressure. The NRC's concern is that a smaller break that does not benefit from the boron injection from the accumulators could potentially be more limiting than the large break DER for Watts Bar. To address this concern, Westinghouse analyzed a spectrum of smaller steam line break sizes for Watts Bar. It was determined that all these cases depressurized to the accumulation actuation pressure and are less limiting than the previously submitted large break DER case.

The NRC has illustrated the concern of a small break that reaches a minimum pressure above the accumulator setpoint via the Point Beach analysis from 1990, as documented in WCAP-12603. At the time, Westinghouse analyzed cases for both hypothetical breaks (large DER of the main steam line) and credible breaks (inadvertent opening of a steam generator safety or relief valve). The 1990 analysis of the credible steam line break modeled a break size of 0.116 ft^2 that does not depressurize the RCS to the accumulator actuation pressure.

A comparison of the Point Beach model and the Watts Bar model revealed that the two cases modeled the break differently. For Point Beach, the break is modeled as a stuck open valve on one loop (non-uniform credible break). The break is asymmetric in that it only affects one steam generator. For Watts Bar, the break was modeled in the same manner as the hypothetical break case, i.e., as a small DER with blow down from all loops until steam line isolation, after which the break flow is terminated from all but one steam generator.

The RCS pressure transient in the 1990 Point Beach credible break case bottoms out a little below 800 psia and then begins to increase. The LOFTRAN input file from that analysis was obtained and the transient was run out to a longer time. To ensure a consistent comparison, an additional Watts Bar SLB case has been run with the break modeled as a stuck open valve of the same flow area as in the Point Beach analysis. The RCS pressure transients are shown in the transient plot below. As shown, for Watts Bar the accumulator setpoint is reached for a credible steam line break of 0.116 ft^2. Pressure decreases to a little above 500 psia. There is no return to power for this case, which is not surprising since the large DER case shows a low return to power for this plant and the same reactivity feedback characteristics are used. The credible break case is bounded by the large DER case presented in the Watts Bar Unit 2 FSAR, as expected.



As described in the audit report, for these credible break cases the pressure eventually rises to the shutoff head of the safety injection pumps or the pressurizer PORV setpoint, whichever is lower. The audit report notes that pressurizer thermal shock (PTS) could become a concern for this scenario. However, the Chapter 15 FSAR safety analysis is not appropriate to assess PTS concerns. Analysis assumptions are intended to maximize the cooldown and depressurization and the subsequent return to power, not to maximize pressurizer filling or to maximize PTS consequences (e.g., minimum safety injection is assumed). Separate evaluations are performed for PTS concerns and documented elsewhere.

Several other transient plots are provided in the audit report. These are 1984 vintage plots for Watts Bar Unit 1 that show a minimum RCS pressure of around 1000 psia. It should be noted that this case included the Upper Head Injection (UHI) accumulator, an original feature of the ice condenser containment plants. The UHI injected 1900 ppm water when the RCS pressure dropped to 1200 psia. The UHI system was eliminated in the 1986 time frame. As a result, RCS pressures fall considerably farther during steam line break analyses performed for Watts Bar after the UHI elimination.

The audit report also notes concerns with the non-limiting nature of the Watts Bar analyses and the lack of concern over the without power cases. These questions have been addressed separately.