WCAP-16500-NP-A
Supplement 1
Revision 1

December 2010

Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)

Westinghouse

WCAP-16500-NP-A
Supplement 1
Revision 1

Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)

Original Version: October 2008

Authors:
M. A. Book
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Approved Version: December 2010

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Section A

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 28, 2009

Mr. James A. Gresham, Manager
Regulatory Compliance and Plant Licensing
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, PA 15230-0355

SUBJECT: FINAL SAFETY EVALUATION FOR WESTINGHOUSE ELECTRIC COMPANY TOPICAL REPORT WCAP-16500-P, SUPPLEMENT 1, REVISION 1, "APPLICATION OF CE SETPOINT METHODOLOGY FOR CE 16x16 NEXT GENERATION FUEL (NGF)" (TAC NO. ME0143)

Dear Mr. Gresham:

By letter dated October 24, 2008, Westinghouse Electric Company (Westinghouse) submitted Topical Report (TR) WCAP-16500-P, Supplement 1, Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)", to the U.S. Nuclear Regulatory Commission (NRC) staff. By letter dated October 26, 2009, an NRC draft safety evaluation (SE) regarding our approval of TR WCAP-16500-P, Supplement 1, Revision 1, was provided for your review and comments. By letter dated November 4, 2009, Westinghouse commented on the draft SE. The NRC staff's disposition of Westinghouse's comments on the draft SE are discussed in the attachment to the final SE enclosed with this letter.

The NRC staff has found that TR WCAP-16500-P, Supplement 1, Revision 1, is acceptable for referencing in licensing applications for pressurized water reactors to the extent specified and under the limitations delineated in the TR and in the enclosed final SE. The final SE defines the basis for our acceptance of the TR.

Our acceptance applies only to material provided in the subject TR. We do not intend to repeat our review of the acceptable material described in the TR. When the TR appears as a reference in license applications, our review will ensure that the material presented applies to the specific plant involved. License amendment requests that deviate from this TR will be subject to a plant-specific review in accordance with applicable review standards.

In accordance with the guidance provided on the NRC website, we request that Westinghouse publish accepted proprietary and non-proprietary versions of this TR within three months of receipt of this letter. The accepted versions shall incorporate this letter and the enclosed final SE after the title page. Also, they must contain historical review information, including NRC requests for additional information and your responses. The accepted versions shall include an "-A" (designating accepted) following the TR identification symbol.

NOTICE: Enclosure 2 transmitted herewith contains proprietary information. When separated form Enclosure 2, this document is decontrolled.

If future changes to the NRC's regulatory requirements affect the acceptability of this TR, Westinghouse and/or licensees referencing it will be expected to revise the TR appropriately, or justify its continued applicability for subsequent referencing.

Sincerely,

Theodore R. Quay for

Thomas B. Blount, Deputy Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 700

Enclosures: 1. Final SE (non-proprietary version)
2. Final SE (proprietary version)

cc w/encl 1 only:

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

FINAL SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TOPICAL REPORT WCAP-16500-P, SUPPLEMENT 1, REVISION 1

"APPLICATION OF CE SETPOINT METHODOLOGY FOR CE 16x16

NEXT GENERATION FUEL (NGF)"

WESTINGHOUSE ELECTRIC COMPANY

PROJECT NO. 700

1.0 INTRODUCTION

By letter dated October 24, 2008 (Reference 1), as supplemented by letter dated August 21, 2009 (Reference 2), Westinghouse Electric Company (Westinghouse) submitted for U.S. Nuclear Regulatory Commission (NRC) staff review Topical Report (TR) WCAP-16500-P, Supplement 1, Revision 1, "Application of CE [Combustion Engineering] Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)." This TR describes a revised analytical process for calculating COLSS and CPCS addressable constants and database constants for plant reloads with CE 16x16 NGF (CE16NGF) assemblies.

2.0 REGULATORY EVALUATION

Regulatory guidance for the review of fuel system designs and adherence to General Design Criteria (GDC) - 10, GDC-27, and GDC-35 is provided in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (SRP), Section 4.2, "Fuel System Design" (Reference 3). In accordance with SRP Section 4.2, the objectives of the fuel system safety review are to provide assurance that:

a. The fuel system is not damaged as a result of normal operation and anticipated operational occurrences,

b. Fuel system damage is never so severe as to prevent control rod insertion when it is required,

c. The number of fuel rod failures is not underestimated for postulated accidents, and coolability is always maintained.

In addition to licensed reload methodologies, an approved mechanical design methodology is utilized to demonstrate compliance to SRP 4.2 fuel design criteria. The NRC staff's prior review of WCAP-16500-P, Revision 0 (Reference 4), was to ensure that the approved reload and fuel mechanical design methodologies (1) remain applicable to the CE16NGF design and (2) adequately addresses the applicable regulatory requirements identified in SRP 4.2. In addition, based upon Lead Test Assemblies, post-irradiation examinations, mechanical testing, past operating experience of similar designs and materials, and fuel performance model predictions, the NRC staff reviewed expected performance of the CE16NGF assembly to ensure it satisfied these requirements.

Supplement 1, Revision 1, addresses deficiencies in the CE digital setpoint methodology identified during review of WCAP-16500-P. Hence, the NRC staff's review builds on its prior review of the CE setpoint methodology described in WCAP-16500-P Supplement 1 as supplemented by request for additional information (RAI) responses (Reference 4).

3.0 TECHNICAL EVALUATION

During its review of WCAP-16500-P (Reference 4), the NRC staff identified potential problems with the application of the CE digital setpoints process, known as Modified Statistical Combination of Uncertainties (MSCU), to reload cores containing CE16NGF assemblies. Specifically, the application of MSCU methods to reloads where the critical heat flux (CHF) correlation within core operating limit supervisory system (COLSS) (i.e., plant monitoring system) and core protection calculator system (CPCS) (i.e., plant protection system) were inconsistent with the axial-dependent CHF correlations of the CE16NGF design. In this application, the two NGF CHF correlations each have the potential to introduce separate temperature-dependent, pressure-dependent, flow-dependent and axial shape index (ASI)-dependent biases.

In response to NRC staff concerns, Westinghouse submitted Supplement 1-P, which detailed the application of CE digital setpoint methodology for CE16NGF assemblies. Section 3.7 of the NRC staff's safety evaluation (Reference 4) documents the NRC staff's review of Supplement 1 along with several subsequent RAIs and an audit. In the end, the NRC staff was unable to reach a safety finding, concluding:

> Based upon these concerns, the NRC staff is unable to conclude that the proposed digital setpoints methodology is (1) consistent with the currently approved methods and (2) will preserve the required 95/95 protection level when applied to the NGF assemblies.

To support batch implementation of CE16NGF assemblies (which offer many advanced features designed to benefit fuel performance), the NRC staff developed an interim departure from nucleate boiling (DNB) margin penalty which was included as a condition on the staff's approval of WCAP-16500-P.

> WCAP-16500-P-A Condition #5:
> To compensate for NRC staff concerns related to the digital setpoints process, an interim margin penalty of 6 percent must be applied to the final addressable constants (e.g., BERR1* 1.06, [(1+EPOL2)*1.06 - 1.0]) calculated following the 1/64 hypercube setpoints process (Response No. 6 of Reference 6). Removal of this interim margin penalty will be considered after the digital setpoints methods have

been formalized, documented (e.g., revision to TR WCAP-16500-P), and approved by the NRC (SE Section 3.7).

Revision 1 of WCAP-16500-P-A, Supplement 1 (Reference 1), documents a revised analytical procedure for performing the MSCU digital setpoint process which accounts for inconsistent CHF correlations in an attempt to remove the above interim DNB penalty. The proposed analytical procedure does not change the underlying MSCU methodology (depicted in Figure 1 of Reference 1) previously approved by the NRC.

In addition to reviewing the material presented in Supplement 1, Revision 1, and in response to RAIs, the NRC staff conducted an audit of the supporting Westinghouse engineering calculations on August 12, 2009, at the Westinghouse Rockville office.

3.1 Revised MSCU Setpoints Process

Section 2 of WCAP-16500-P, Supplement 1, Revision 1, describes the revised MSCU setpoints process for application to core reloads with a full core of CE16NGF. A detailed description of each analytical step is documented in Section 2.4 of WCAP-16500-P, Supplement 1, Revision 1. This revised analytical process is intended to address NRC staff concerns documented in Reference 4.

The two CE16NGF CHF correlations (i.e., above and below elevation of first mixing grid) each have the potential to introduce separate temperature-dependent, pressure-dependent, flow-dependent and ASI-dependent biases. Analytical steps #1 - #3 describe the process for separately evaluating these potential biases and defining the limiting operating space within the 1/64th hypercube. In response to an RAI regarding the **[ ]** acceptance criterion on DNB power operating limit (POL) used to assess whether to perform the MSCU within a limited range of temperature, pressure, and mass flux (i.e., 1/64 hypercube) (RAI #2, Reference 2), Westinghouse stated that **[**

] The NRC staff finds this acceptance criterion acceptable.

Westinghouse states that the hypercube "divide operating space into sufficiently small regions such that any correlation in DNBR [departure from nucleate boiling ratio] uncertainty within the hypercube is insignificant" (Section 2.3 of WCAP-16500-P, Supplement 1, Revision 1). Based upon an evaluation of the sample **[ ]** reload analyses documented in Section 2.5 of WCAP-16500-P, Supplement 1, Revision 1, and the **[**
] reload analyses reviewed during the NRC staff audit (Reference 5), the NRC staff finds the level of division in the 1/64th hypercube methodology acceptable.

Analytical step #4 is used to investigate the axial power distribution (referred to as axial shape index (ASI)) dependence of the DNB POL error in both the COLSS range (narrow) and CPCS range (wide) of operating space. Examination of Figure 20 of WCAP-16500-P, Supplement 1, Revision 1, reveals this evaluation for the sample **[ ]** reload analysis and illustrates two distinct, non-poolable data sets. These distinct regions result from the placement of mixing vanes in the top 2/3 of the CE16NGF assembly and differences between the WSSV-T and critical heat flux correlation for non-vaned fuel (ABB-NV) CHF correlations (relative to CE-1 CHF correlation). It is expected that these differences will always result in two distinct, non-poolable data sets. Nevertheless, the revised set point process includes a statistical test to assess poolability (see analytical step #6). The result of analytical step #4 is a set of ASI ranges defining the breakpoints and transition zone for these two regions.

Analytical step #5 runs the core protection calculators (CPC) MSCU using the limiting 1/64th hypercube of step #3 over the entire ASI range and [ ] In analytical step #7, the three raw BERR1 values are used to calculate ASI-dependent COLSS and CPCS database constants which will act as heat flux penalties in the on-line DNBR calculations in the transition region and more positive ASI range (lower portion of the core below 1st mixing vane). Incorporating ASI-dependent database penalties allows the use of the more benign BERR1 values (and EPOL2 in COLSS) associated with the top portion of the core. This strategy promotes more DNB margin benefit since the BERR1/EPOL2 values associated with the WSSV-T CHF are employed during normal operating conditions.

Analytical step #8 performs the final COLSS and CPC MSCU analyses incorporating the limiting 1/64th hypercube of step #3 [ ] defined in step #4 at each time in cycle applying the COLSS and CPC database ASI-dependent adjustment factors from step #7. [ ]

In the proposed setpoint methodology, [ ] (RAI #1, Reference 2). These modified codes would subsequently be utilized to calculate new addressable constants and provide a thermal margin benchmark. In response to RAI #1, Westinghouse proposed an alternative approach which [ ] Note that this approach is different from just replacing the CE-1 correlation with the NGF correlations in that it [ ] Further, Westinghouse stated that this work scope would not be complete until March 2010. In the interim, the NRC staff recommends that a 3 percent margin penalty be applied to the final addressable constants (e.g., BERR1* 1.03, [(1+EPOL2)*1.03 - 1.0]) calculated in accordance with the revised analytical steps until such time as Westinghouse provides an acceptable written response to RAI #1. This 3 percent margin penalty supersedes the previous 6 percent interim margin penalty (condition specified in Reference 4) and provides reasonable assurance that the COLSS and CPCS DNBR calculations remain conservative (given the revised analytical steps which address the NRC staff's earlier concerns).

In response to an RAI regarding treatment of CETOP-D/TORC correction factors within the revised setpoint process (RAI #3, Reference 2), Westinghouse stated that the [

] The NRC staff finds this approach acceptable.

In response to an RAI regarding the historical basis for the values of CPC constants E1 and E2 (RAI #4, Reference 2), Westinghouse described the use of these CPC constants in the new process as well as their historic values. While the values may be changing, the functional basis of E1 and E2 remain consistent with the approved methodology.

In response to an RAI regarding the DNB POL error in the ASI transition region (RAI #5, Reference 2), Westinghouse stated that the revised process will compensate for any points where the ASI dependent functions are non-conservative due to unexpected non-linearity. [

] This assures that the combination of the addressable values and ASI-dependent database adjustments yield conservative results over the entire ASI range.

In response to an RAI regarding a minimum number of MSCU cases to ensure a statistically significant population (RAI #6, Reference 2), Westinghouse described the different sets of cases used in COLSS analyses relative to CPC analyses as well as time in cycle specific case sets. This approach ensures a large number of cases in the statistical analyses. Westinghouse further stated that the process has the capability of detecting a significant misdistribution of cases versus ASI. This ensures that each respective case set evenly and thoroughly encompasses the allowable ASI range.

On August 12, 2009, the NRC staff conducted an audit of Westinghouse engineering calculations supporting the [ ] core reload. This reload is the first application of the revised analytical procedures described within WCAP-16500-P, Supplement 1, Revision 1. The audit report (Reference 5) captures the NRC staff's assessment of the modified MSCU process.

Based upon a review of the material presented in WCAP-16500-P, Supplement 1, Revision 1, and in response to RAIs, as well as the audit of [ ] core reload calculations, the NRC staff finds that the revised MSCU analytical process adequately addresses earlier concerns with the application of the CE MSCU set points methodology to reload cores containing CE16NGF assemblies. As such, the interim DNB margin penalty (6 percent) dictated via WCAP-16500-P, SE Condition #5 (Reference 4) is no longer required.

4.0 LIMITATIONS AND CONDITIONS

Licensees referencing WCAP-16500-P, Supplement 1, Revision 1, must ensure compliance with the following conditions and limitations:

> Until Westinghouse provides an acceptable written response to RAI #1, an interim margin penalty of 3.0 percent must be applied to the final addressable constants (e.g., BERR1* 1.03, [(1+EPOL2)*1.03 - 1.0]) calculated following the analytical steps defined in WCAP-16500-P, Supplement 1, Revision 1.

5.0 CONCLUSION

Based upon a review of the material presented in WCAP-16500-P, Supplement 1, Revision 1, and in response to RAIs, as well as the audit of [ ] core reload calculations, the NRC staff finds that the revised MSCU analytical process adequately addresses earlier concerns with the application of the CE MSCU set points methodology to reload cores containing CE16NGF assemblies. As such, the interim DNB margin penalty (6 percent) dictated via WCAP-16500-P, SE Condition #5 (Reference 4) is no longer required. Licensees referencing this TR will need to comply with the conditions listed in Section 4.0 of this SE.

6.0 REFERENCES

1. Letter from J. A. Gresham (W) to U.S. Nuclear Regulatory Commission, "Submittal of WCAP-16500-P Supplement 1 Revision 1 / WCAP-16500-NP, Supplement 1, Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)," LTR-NRC-08-52, October 24, 2008.

2. Letter from J. A. Gresham (W) to U.S. Nuclear Regulatory Commission, "Response to the NRC's Request for Additional Information by the Office of Nuclear Reactor Regulation for Topical Report (TR) WCAP-16500-P, Supplement 1, Revision 1, 'Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)'," LTR-NRC-09-44, August 21, 2009.

3. NUREG-0800, Standard Review Plan, Section 4.2, "Fuel System Design," Revision 3, March 2007.

4. Letter from U.S. Nuclear Regulatory Commission to J. A. Gresham (W), "Final Safety Evaluation for Westinghouse Electric Company (Westinghouse) Topical Report (TR) WCAP-16500-P, Revision 0, 'CE [Combustion Engineering] 16X16 Next Generation Fuel [(NGF)] Core Reference Report'," July 30, 2007.

5. NRC Memorandum, "Audit Report for WCAP-16500-P, Supplement 1, Revision 1, 'Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel'," August 24, 2009.

Attachment: Resolution of Comments

Principle Contributor: Paul Clifford (NRR/DSS)

Date: December 28, 2009

RESOLUTION OF WESTINGHOUSE ELECTRIC COMPANY COMMENTS ON DRAFT SAFETY EVALUATION FOR TOPICAL REPORT WCAP-16500-P, SUPPLEMENT 1, REVISION 1 "APPLICATION OF CE SETPOINT METHODOLOGY FOR CE 16X16 NEXT GENERATION FUEL (NGF)" WESTINGHOUSE ELECTRIC COMPANY (TAC NO. ME0143)

By letter dated November 4, 2009, Westinghouse Electric Company (Westinghouse) provided four comments on the draft safety evaluation (SE) for Topical Report (TR) WCAP-16500-P-, Supplement 1, Revision 1, "Application of CE Setpoint Methodology for CE 16X16 Next Generation Fuel (NGF)". Some information in the draft SE for this TR was identified as proprietary; therefore, the draft of this SE will not be made publicly available. The following are the NRC staff's resolution of these comments:

Draft SE comments for TR WCAP-16500-P, Supplement 1, Revision 1:

1. The last sentence in Section 3.0, paragraph 1, states that "...separate temperature-dependent, pressure-dependent, and flow-dependent biases as a function of axial power shape." Westinghouse proposed the following change:

   "...separate temperature-dependent, pressure-dependent, flow-dependent and axial shape index (ASI)-dependent biases."

   NRC Resolution for Comment 1 on Draft SE:

   The NRC staff reviewed the Westinghouse recommendation and found it acceptable because the change is editorial in nature.

   The last sentence in Section 3.0, paragraph 1, is changed to read:

   "In this application, the two NGF CHF correlations each have the potential to introduce separate temperature-dependent, pressure-dependent, flow-dependent and axial shape index (ASI)-dependent biases."

ATTACHMENT

2. The first sentence of Section 3.1, paragraph 2, states that "...separate temperature-dependent, pressure-dependent, and flow-dependent biases as a function of axial power shape." Westinghouse proposed the following change:

> "...separate temperature-dependent, pressure-dependent, flow-dependent and axial shape index (ASI)-dependent biases."

NRC Resolution for Comment 2 on Draft SE:

The NRC staff has reviewed the Westinghouse suggestion, and found it acceptable to reword as follows:

The first sentence of Section 3.1, paragraph 2, is changed to read:

> "The two CE16NGF CHF correlations (i.e., above and below elevation of first mixing grid) each have the potential to introduce separate temperature-dependent, pressure-dependent, flow-dependent and ASI-dependent biases."

3. The second sentence of Section 3.1, paragraph 7, states that states that "[ ]" Westinghouse proposed the following change:

"[ ]."

NRC Resolution for Comment 3 on Draft SE:

The NRC staff has reviewed the Westinghouse suggestion, and found it acceptable to reword as follows.

The second sentence of Section 3.1, paragraph 7, is changed to read:

[

]

4. The fifth sentence of Section 3.1, paragraph 7, states that "[ ]" Westinghouse proposed the following change:

"[ ]."

NRC Resolution for Comment 4 on Draft SE:

The NRC staff has reviewed the Westinghouse suggestion, and found it acceptable to reword as follows.

The fifth sentence of Section 3.1, paragraph 7, is changed to read:

In response to RAI #1, Westinghouse proposed an alternative approach [

]

Section B

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 1, 2010

Mr. James A. Gresham, Manager
Regulatory Compliance and Plant Licensing
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, PA 15230-0355

SUBJECT: FINAL SAFETY EVALUATION FOR WESTINGHOUSE ELECTRIC COMPANY ADDENDUM 1 TO TOPICAL REPORT WCAP-16500-P, SUPPLEMENT 1, REVISION 1, "APPLICATION OF CE SETPOINT METHODOLOGY FOR CE 16X16 NEXT GENERATION FUEL (NGF)," (TAC NO. ME3583)

Dear Mr. Gresham:

By letter dated March 9, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML100740384), Westinghouse Electric Company submitted for U.S. Nuclear Regulatory Commission (NRC) staff review Addendum 1 to Topical Report (TR) WCAP-16500-P, Supplement 1, Revision 1, "Application of CE Setpoint Methodology for CE 16X16 Next Generation Fuel (NGF)." By letter dated June 7, 2010, an NRC draft safety evaluation (SE) regarding our approval of Addendum 1 to TR WCAP-16500-P, Supplement 1, Revision 1, was provided for your review and comments. By e-mail dated June 15, 2010 (ADAMS Accession No. ML101690134), Westinghouse indicated that Addendum 1 to TR WCAP-16500-P, Supplement 1, Revision 1, does not contain any proprietary information and that Westinghouse does not have any comments on the draft SE.

The NRC staff has found that Addendum 1 to TR WCAP-16500-P, Supplement 1, Revision 1, is acceptable for referencing in licensing applications for pressurized water reactors to the extent specified and under the limitations delineated in the TR and in the enclosed final SE. The final SE defines the basis for our acceptance of the TR.

Our acceptance applies only to material provided in the subject TR. We do not intend to repeat our review of the acceptable material described in the TR. When the TR appears as a reference in license applications, our review will ensure that the material presented applies to the specific plant involved. License amendment requests that deviate from this TR will be subject to a plant-specific review in accordance with applicable review standards.

In accordance with the guidance provided on the NRC website, we request that Westinghouse publish the accepted version of this TR within three months of receipt of this letter. The accepted version shall incorporate this letter and the enclosed final SE after the title page. Also, it must contain historical review information, including NRC requests for additional information and your responses. The accepted versions shall include an "-A" (designating accepted) following the TR identification symbol.

As an alternative to including the RAIs and RAI responses behind the title page, if changes to the TR were provided to the NRC staff to support the resolution of RAI responses, and the NRC staff reviewed and approved those changes as described in the RAI responses, there are two ways that the accepted version can capture the RAIs:

1. The RAIs and RAI responses can be included as an Appendix to the accepted version.

2. The RAIs and RAI responses can be captured in the form of a table (inserted after the final SE) which summarizes the changes as shown in the approved version of the TR. The table should reference the specific RAIs and RAI responses which resulted in any changes, as shown in the accepted version of the TR.

If future changes to the NRC's regulatory requirements affect the acceptability of this TR, Westinghouse and/or licensees referencing it will be expected to revise the TR appropriately, or justify its continued applicability for subsequent referencing.

Sincerely,

Thomas B. Blount

Thomas B. Blount, Deputy Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 700

Enclosure: Final SE

cc w/encl: See next page

Westinghouse Electric Project No. 700

cc:

Mr. Kris Cummings, Manager
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

FINAL SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ADDENDUM 1 TO WCAP-16500, SUPPLEMENT 1, REVISION 1,

"APPLICATION OF CE SETPOINT METHODOLOGY FOR

CE 16X16 NEXT GENERATION FUEL (NGF)"

WESTINGHOUSE ELECTRIC COMPANY

PROJECT NO. 700

1.0 INTRODUCTION AND BACKGROUND

By letter dated March 9, 2010 (Reference 1), Westinghouse Electric Company Nuclear Services (Westinghouse) submitted for U.S. Nuclear Regulatory Commission (NRC) staff review Addendum 1 to Topical Report (TR) WCAP-16500-P, Supplement 1, Revision 1, "Application of CE Setpoint Methodology for CE 16X16 Next Generation Fuel (NGF)." This TR incorporates a response to the previous request for additional information (RAI) and requests removal of an interim margin penalty imposed by the NRC staff on the Combustion Engineering (CE) setpoint methodology detailed in WCAP-16500-P, Supplement 1, Revision 1 TR (Reference 2).

2.0 REGULATORY EVALUATION

Regulatory guidance for the review of fuel system designs and adherence to applicable General Design Criteria (GDC) is provided in Section 4.2, "Fuel System Design" of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (SRP 4.2) (Reference 3). In accordance with SRP 4.2, the objectives of the fuel system safety review are to provide assurance that:

a. The fuel system is not damaged as a result of normal operation and anticipated operational occurrences (AOOs),

b. Fuel system damage is never so severe as to prevent control rod insertion when it is required,

c. The number of fuel rod failures is not underestimated for postulated accidents, and

d. Coolability is always maintained.

ENCLOSURE

In addition to licensed reload methodologies, an approved mechanical design methodology is utilized to demonstrate compliance to SRP 4.2 fuel design criteria. The NRC staff's original review of WCAP-16500-P, Supplement 1, Revision 1, TR (Reference 4) was done to ensure that the approved reload and fuel mechanical design methodologies (1) remain applicable to the NGF design, and (2) adequately addresses the applicable regulatory requirements identified in SRP 4.2. In addition, based upon Lead Test Assemblies (LTAs), post-irradiation examinations (PIEs), mechanical testing, past operating experience of similar designs and materials, and fuel performance model predictions, the NRC staff reviewed expected performance of the CE16NGF assembly to ensure it satisfied these requirements.

WCAP-16500-P, Supplement 1, Revision 1, addressed deficiencies in the CE digital setpoint methodology identified during the NRC staff's original review of this TR. The NRC staff's review of TR found the revised digital setpoint methodology acceptable, but imposed an interim departure from nucleate boiling (DNB) penalty until Westinghouse provides an acceptable response to Request for Additional Information (RAI) #1 (Reference 2). This current review focuses on Westinghouse's supplemental response to RAI #1. Hence, the NRC staff's review is based on its prior reviews of the CE16NGF (Reference 4) and CE digital setpoint methodology (Reference 2).

3.0 TECHNICAL EVALUATION

During its review of WCAP-16500-P, Supplement 1, Revision 1, (Reference 2), the NRC staff found the revised CE digital setpoint methodology acceptable, but imposed an interim DNB penalty until Westinghouse provides an acceptable response to RAI #1. The condition in the NRC staff's safety evaluation for WCAP-16500-P, Supplement 1, Revision 1, states:

> Licensees referencing WCAP-16500-P, Supplement 1, Revision 1, must ensure compliance with the following conditions and limitations:
>
> > Until Westinghouse provides an acceptable written response to RAI #1, an interim margin penalty of 3.0 percent must be applied to the final addressable constants (e.g., BERR1* 1.03, [(1+EPOL2)*1.03 – 1.0]) calculated following the analytical steps defined in WCAP-16500-P, Supplement 1, Revision 1.

The NRC staff requested that Westinghouse modify COLSIM and CPCSIM algorithms and perform DNB thermal margin calculations to assess the overall conservatism of the revised digital setpoint methodology in RAI #1 (Reference 2). Westinghouse provided the results of the requested calculations at several different reload depletion steps and axial power distributions for two recent reload campaigns in Reference 1. Examination of the results of these calculations confirms that the digital setpoint process detailed in WCAP-16500-P, Supplement 1, Revision 1, is conservative. Based upon its review of the requested calculations, the NRC staff finds Westinghouse's response to RAI #1 acceptable. Therefore, the previously imposed 3.0 percent interim DNB penalty is no longer required.

4.0 LIMITATIONS AND CONDITIONS

No new conditions and limitations.

5.0 CONCLUSION

Based upon a review of the material presented in Addendum 1 to WCAP-16500-P, Supplement 1, Revision 1, the NRC staff finds that the CE digital setpoint process acceptable to reload cores containing CE16NGF assemblies. As such, prior interim DNB margin penalties (6.0 percent dictated via Condition #5 in WCAP-16500-P, Reference 4, and 3.0 percent dictated via WCAP-16500-P, Supplement 1, Revision 1, Reference 2) are no longer required. Licensees referencing this TR will need to comply with remaining conditions and limitations from WCAP-16500-P, Revision 0, (Reference 4).

6.0 REFERENCES

1. Letter from J. A. Gresham (Westinghouse) to U.S. Nuclear Regulatory Commission, "Addendum 1 to WCAP-16500-P, Supplement 1, Revision 1, 'Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF) (Follow-up Response to NRC RAI #1)'," LTR-NRC-10-14, March 9, 2010. (ADAMS Accession No. ML100740384)

2. Letter from U.S. Nuclear Regulatory Commission to J. A. Gresham (W), "Final Safety Evaluation for Westinghouse Electric Company Topical Report WCAP-16500-P, Supplement 1, Revision 1, 'Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)'," December 28, 2009. (ADAMS Accession No. ML093280716)

3. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Section 4.2, "Fuel System Design," U.S. NRC, March 2007.

4. Letter from U.S. Nuclear Regulatory Commission to J. A. Gresham (Westinghouse), "Final Safety Evaluation for Westinghouse Electric Company (Westinghouse) Topical Report (TR) WCAP-16500-P, Revision 0, 'CE [Combustion Engineering] 16X16 Next Generation Fuel [(NGF)] Core Reference Report'," July 30, 2007. (ADAMS Accession No. ML071920269)

Principle Contributor: Paul Clifford (NRR/DSS)

Date: July 1, 2010

Section C

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Our ref: LTR-NRC-08-52
October 24, 2008

Subject: Submittal of WCAP-16500-P Supplement 1 Revision 1/WCAP-16500-NP Supplement 1 Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)" (Proprietary/Non-Proprietary)

Enclosed are Proprietary and Non-Proprietary copies of WCAP-16500-P Supplement 1 Revision 1/WCAP-16500-NP Supplement 1 Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)", submitted to the NRC for review and approval. Westinghouse requests that the above submittal be approved by October, 2009, as discussed at the September 22, 2008 pre-submittal meeting held with the NRC in Rockville, MD.

Also enclosed is:

1. One (1) copy of the Application for Withholding, AW-08-2491 (Non-proprietary) with Proprietary Information Notice.
2. One (1) copy of Affidavit (Non-proprietary).

This submittal contains proprietary information of Westinghouse Electric Company, LLC. In conformance with the requirements of 10 CFR Section 2.390, as amended, of the Commission's regulations, we are enclosing with this submittal an Application for Withholding from Public Disclosure and an affidavit. The affidavit sets forth the basis on which the information identified as proprietary may be withheld from public disclosure by the Commission.

Correspondence with respect to the affidavit or Application for Withholding should reference AW-08-2491 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Enclosures
cc: G. Bacuta, NRR
P. Clifford, NRR

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Our ref: AW-08-2491
October 24, 2008

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: Submittal of WCAP-16500-P Supplement 1 Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)" (Proprietary)

Reference: Letter from J. A. Gresham to Document Control Desk, LTR-NRC-08-52, dated October 24, 2008

The application for withholding is submitted by Westinghouse Electric Company LLC (Westinghouse) pursuant to the provisions of paragraph (b)(1) of Section 2.390 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10 CFR Section 2.390, Affidavit AW-08-2491 accompanies this application for withholding, setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

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

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-08-2491 and should be addressed to J. A. Gresham, Manager of Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P. O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Cc: G. Bacuta, NRR
P. Clifford, NRR

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

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 and Plant Licensing

Sworn to and subscribed
before me this 24th day
of October, 2008.

Margaret L Gonano
Notary Public

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Margaret L. Gonano, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Jan. 3, 2010
Member, Pennsylvania Association of Notaries

(1) I am Manager, Regulatory Compliance and Plant Licensing, 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 rulemaking 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" 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 which 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 WCAP-16500-P Supplement 1 Revision 1 (Proprietary), for submittal to the Commission, being transmitted by Westinghouse letter (LTR-NRC-08-52) and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk. The proprietary information as submitted by Westinghouse Electric Company is for NRC review and approval.

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

(a) Clarify the application of CE setpoint methodology for CE 16x16 NGF.
(b) Assist customers in implementing an improved fuel product.

Further this information has substantial commercial value as follows:

(a) Westinghouse can use the CE 16x16 NGF fuel design with associated setpoint methodology to further enhance their licensing position over their competitors.
(b) Assist customers to obtain license changes.

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 fuel design 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.

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1.0 Introduction and Background

1.1 Introduction

1.1.1 Purpose

The purpose of this supplement is to describe the application of the CE setpoint methodology to plants with CE 16x16 Next Generation Fuel (NGF). The CE setpoint methodology involves the modified statistical combination of uncertainties (MSCU) methodology as described in Reference 1. MSCU calculates setpoints for the digital protection and monitoring systems employed at several CE designed Nuclear Steam Supply Systems (NSSS). Application of the MSCU methodology to plants with NGF requires process and input changes in order to model the NGF design and address its thermal hydraulic characteristics.

1.1.2 Introduction to CPCS & COLSS

The Core Protection Calculator System (CPCS) is part of the reactor protection system (RPS). It consists of Core Protection Calculators (CPCs) and Control Element Assembly Calculators (CEACs). The CPC functional design is described in Reference 2 and the CEAC functional design is described in Reference 3. The CPCS initiates the low DNBR and high Local Power Density (LPD) trips of the RPS in order to assure that fuel design limits on DNBR and centerline fuel melting are not exceeded during Anticipated Operational Occurrences (AOOs) and to assist the Engineered Safety Features Actuation System (ESFAS) in limiting the consequences of certain postulated accidents. Each CPC channel receives safety grade sensor inputs and calculates DNBR, LPD and other quantities. The CEACs receive safety grade CEA position inputs and provide single CEA position-related penalty factors to each CPC channel such that the CPCs respond appropriately to single CEA–related AOOs which require CPC protection.

The Core Operating Limit Supervisory System (COLSS) is a digital computer based on-line monitoring system that is used to issue alarm signals to the plant computer and to provide information to aid the operator in complying with Technical Specification operating limits on total core power, peak linear heat rate (LHR), DNBR, axial shape index (ASI) and azimuthal power tilt. An overview description of COLSS is provided in Reference 4.

The CPCS and COLSS include [

]^{a,c} in order to decide whether to issue a trip signal to the RPS. The algorithm in COLSS [

]^{a,c} in order to decide whether to issue an alarm signal to the plant computer.

1.1.3 Purpose of Setpoint Analysis

The setpoint analysis for CE NSSS with digital monitoring and protection systems is performed every reload cycle in order to calculate addressable constants for the CPCS and COLSS. Addressable constants are coefficients of the CPCS or COLSS algorithms which can be changed readily during startup or operation. Addressable constants include calibration coefficients, measurement results, uncertainty factors, adjustment factors, time delays and trip setpoints. The primary purpose of the cycle specific setpoint analysis is to calculate the CPCS and COLSS uncertainty factors.

1.1.4 How NGF Impacts Setpoint Analysis Methodology & Process

Implementation of NGF, as described in Reference 12, impacts the setpoint analysis methodology and process in four areas:

1. [
2.
3.
4.

]^{a,c}

The process for addressing these areas is described in this supplement.

1.2 Background

1.2.1 History of Uncertainty Analysis Methodology

The original uncertainty analysis methodology for CPC was documented in Reference 10, referenced in the ANO-2 Cycle 1 FSAR and approved in the ANO-2 Cycle 1 SERs. This methodology included three areas of statistical treatment and/or combination:

1. Statistical treatment of DNBR uncertainties resulting from the power distribution synthesis in CPC and the radial peaking factor measurement errors using the INCA code.
2. Statistical treatment of the DNBR uncertainties resulting from the error in the DNBR on-line algorithm CPCTH, a curve fit of DNBR vs thermal hydraulic conditions, compared to the design code COSMO.
3. Statistical combination of these synthesis, algorithm and radial peaking factor measurement uncertainties.

Other uncertainties, including those for thermal hydraulic parameter measurement, system parameters and the CHF correlation, were treated deterministically in the original CPC uncertainty analysis methodology.

Initially approved for ANO-2 Cycle 2 and SONGS-2 Cycle 1, the statistical combination of uncertainties methodology was documented in separate topicals for each plant (Reference 11) and approved in plant specific SERs. This methodology consisted of [

]^{a,c} In addition, power measurement uncertainties were also calculated statistically but applied deterministically.

The Modified Statistical Combination of Uncertainties (MSCU) methodology was submitted and approved for PVNGS (Reference 1) and applied generically for all CE plants using the CPCS and COLSS via plant specific submittals and approvals. This methodology [

]^{a,c} It also allows for

determination and implementation of burnup, ASI and power dependent uncertainty factors. This methodology is in use at all CE plants using the CPCS and COLSS.

1.2.2 Overview of Methodology & Process

Figure 1 is a flow chart of the MSCU overall uncertainty analysis process as documented and approved in Reference 1 and in use at all CE plants using the CPCS and COLSS. The process consists of the following steps:

1. [

2.

3.

4.

5.

]^{a,c}

The uncertainty analysis results consist of COLSS uncertainty factors for DNB POL, LHR POL, ASI and secondary calorimetric power and CPC uncertainty factors for DNBR, LPD, power and ASI. The key DNBR-related results are the EPOL addressable constants for COLSS and BERR1 for CPC.

2.0 Application of MSCU Methodology to CE 16 x 16 NGF

2.1 Introduction

The MSCU methodology is documented in Reference 1 and the process for performing an uncertainty analysis using the MSCU methodology is illustrated in Figure 1. This section describes the process for applying the MSCU methodology to plants with CE 16 x 16 NGF assemblies. The NGF design is described in Reference 12.

2.2 Methodology, Process and Input

Implementation of NGF impacts the setpoint analysis methodology and process in four areas, as listed in Section 1.1.4:

1. [
2.
3.
4.]^{a,c}

Items 1 through 3 are addressed automatically in the MSCU process. On Figure 1, the inputs to the box [

]^{a,c} In addition, the correction factors between TORC and CETOP-D reflect the fact that both TORC and CETOP-D model the NGF design and contain the NGF CHF correlations. [

]^{a,c} Calculating the DNBOPM error using the equation in step 4 of Section 1.2.2 (per Section 3.4 of Reference 1) automatically accounts for the difference between the [

]^{a,c}

The COLSS DNB POL and CPCS DNBR uncertainty factors, EPOL and BERR1, respectively, calculated using the methodology documented and approved in Reference 1 and adjustments in the MSCU process and inputs to implement and model NGF, will automatically reflect the impact of the NGF design, CHF correlations, DNBR limit and [ ]^{a,c}

2.3 Statistical Evaluation

The NGF design includes grids with mixing vanes for only the top two-thirds portion of the axial height of the active fuel. These mixing grids improve CHF performance relative to grids without mixing vanes, resulting in increased DNB margin. [

]^{a,c} This difference, combined with the difference between [

]^{a,c} yields a strong dependence of the DNB POL and DNBR uncertainty factors on ASI and a weak but statistically significant correlation of the uncertainty factors with temperature and pressure.

2.3.1 Dependence on ASI

The dependence of the uncertainty factors on ASI was investigated by a clean CETOP-D comparison of the NGF model and CHF correlations with the standard fuel model and CE-1 correlation for the hot pin power distributions used to calculate the uncertainty factors. Figure 2 provides a comparison showing typical ASI dependent characteristics. The separation of the POL ratio vs ASI data into two populations with a transition between ASI = +0.2 and ASI = +0.4 is clearly caused by the two grid types. This figure shows that the CETOP-D model for standard fuel with CE-1 yields conservative DNB POL results relative to the CETOP-D model for NGF with the NGF correlations. The conservatism decreases noticeably at ASI more positive than approximately +0.2. Therefore, the COLSS DNB POL and CPC DNBR uncertainty factors calculated for NGF should have a break points at approximately +0.2 and +0.4 ASI.

Figure 2 shows the potential for ASI dependence of the uncertainty factors most clearly since it is a clean comparison between the NGF model and the standard fuel model. [

]^{a,c} The ASI dependence in Figure 3 is not as strong as that in Figure 2.

Based on the comparisons illustrated in Figures 2 and 3, the ASI dependence of the uncertainty factors was investigated by calculating the CPC DNBR addressable constant uncertainty factor BERR1 for the full CPC ASI range (-0.6 to +0.6), bottom peaked shapes only (+0.3 to +0.6) and middle and top peaked shapes only (-0.6 to +0.1). For a typical set of power distributions, the full range BERR1 value was 1.0525, the bottom peaked shapes BERR1 value was 1.1021 and the middle and top peaked shapes BERR1 value was 0.9781. These results show that the full range BERR1 value would be non-conservative for bottom peaked shapes and too conservative for middle and top peaked shapes. The effect on the COLSS uncertainty factor is less since the ASI range for COLSS is narrower. A more detailed sample analysis is presented in Section 2.5.

Both COLSS and CPC algorithms contain ASI dependent multiplicative factors (e.g. see Section 4.3.7 of Reference 2) which can be used to penalize portions of the ASI range to compensate for the ASI dependence of the uncertainty factors. Using ASI dependent multiplicative factors which ramp in from 1.0 at +0.2 to 1.12 at +0.3, the full range, bottom peaked shapes and middle and top peaked shapes in the above example, resultant BERR1 values are within 1% of each other. Appropriate ASI dependent multiplicative factors will be determined each cycle so that the uncertainty factors calculated over the full ASI range will be valid. This process is consistent with the methodology for implementing ASI dependent uncertainty factors as documented in Reference 1.

2.3.2 Dependence on Temperature, Pressure and Flow

There are small but statistically significant correlations of the DNB POL and DNBR uncertainty factors with temperature and pressure in addition to the ASI dependence. These correlations are caused by [

]^{a,c} As a result, the uncertainty factors decrease with increased temperature or decreased pressure. The correlation with flow is insignificant.

Figures 4 - 9 illustrate the dependence of the COLSS DNB POL uncertainty on pressure, temperature and flow. Each figure provides a scatterplot and trend line (least squares fit to the data). A correlation coefficient is calculated for each data set. The correlation coefficient is defined (Reference 14, Section 4.8, equation 4.8.16) as:

$$r_{x,y} = \frac{\frac{1}{n-1}\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{s_X \bullet s_Y}$$

Where $r_{x,y}$ is a sample correlation coefficient, n is the sample size, x_i are the values of the independent variable (e.g., temperature, pressure or flow), y_i are the values of the dependent variable (e.g., DNBPOL uncertainty), x-bar and y-bar are the means of x and y, and s_x and s_y are the standard deviations of x and y.

Figure 4 is a scatter plot of the COLSS DNB POL uncertainty for an NGF cycle as a function of pressure showing the trend and correlation coefficient of +0.21. Figure 5 is a similar plot for a non-NGF cycle showing a statistically insignificant correlation coefficient of +0.03. Figures 6 and 7 are similar plots as a function of temperature where the NGF correlation coefficient is -0.13 and the non-NGF correlation coefficient is +0.03. Figures 8 and 9 show that the correlation coefficients for NGF and non-NGF cycles as a function of flow are essentially 0.0.

In order to evaluate the impact of the correlations of DNB POL and DNBR uncertainty with temperature, pressure and flow, the operating space was divided into 4 x 4 x 4 = 64 hypercubes composed of 25% of the full range for each parameter. The CPC addressable constant BERR1 was calculated for the full range of thermal hydraulic conditions, the "most DNB margin" hypercube (i.e. highest pressure, lowest temperature and highest flow) and the "least DNB margin" hypercube (i.e. lowest pressure, highest temperature and lowest flow). It was determined that the "most margin" hypercube yields the most conservative BERR1 value. The hypercubes divide operating space into sufficiently small regions such that any correlation in DNBR uncertainty within the hypercube is insignificant.

The cycle specific analysis will test for correlations with temperature, pressure and flow and, if present, utilize the "most margin" portion of the full range of each parameter in order to calculate the uncertainty factors. These uncertainty factors will then be applied conservatively over all of operating space. A more detailed sample analysis is presented in Section 2.5.

2.4 Implementation

The process that implements the MSCU methodology has been modified to address the statistical issues discussed in Section 2.3. This section outlines the process as it has been modified and Section 2.5 provides sample results of the modified process. The MSCU methodology described in Reference 1 automatically addresses the first three items listed in Section 2.2 since the CETOP-D code and models have been modified to incorporate the NGF design and CHF correlations. Therefore, the only modifications to the approved process that are necessary to address the NGF-related effect are those involving the statistical evaluations to account for the benefit associated with mixing grids and assure validity over the entire range of operating space.

An eight step process has been developed which addresses:

1. [
2.

]^{a,c}

The following eight steps are performed for the analysis of each reload with a full core of NGF assemblies. Results of a sample analysis using the modified process are presented in Section 2.5.

Step 1: Perform standard MSCU analyses at selected times in cycle for COLSS and CPC over the entire range of temperature, pressure, flow and ASI. This step is consistent with the process described in Section 1.2.2 and illustrated in Figure 1 except that the CETOP-D code and models reflect the NGF design and CHF correlations. The ASI dependence and potential correlation to temperature, pressure and/or flow is not addressed in this step. Instead, this step provides a base set of data in order to address these issues.

Step 2: Using the results of the analyses performed in Step 1, plot the DNB POL error for COLSS and CPC at each time in cycle as a function of temperature, pressure and flow including the trend line. [

]^{a,c} This step is only used to provide a graphical picture of the potential correlation of the error to temperature, pressure and flow.

Step 3: Calculate the correlation coefficient for each set of data from Step 2 and determine whether the correlation of the DNB POL error for COLSS or CPC at each time in cycle is significant by comparing it to the acceptance criterion of [

]^{a,c}

The results of the sample analysis presented in Section 2.5 demonstrate that the [

]^{a,c} In addition, the [ ]^{a,c} has consistently been determined to be the most limiting for the uncertainty analysis results.

It is expected that the results of this step will be consistent from cycle to cycle such that the [

]^{a,c}

Step 4: Perform [

]^{a,c}

These analyses use the limiting 1/64th hypercube of temperature, pressure and flow ranges determined in Step 3. They provide a clear comparison of the DNB behavior of the standard fuel design and NGF by eliminating all variations from the best estimate POL calculations.

Plot the relative percent difference [
]^{a,c} for each time in cycle and the composite of all times in cycle for COLSS and for CPC. In addition, create a single composite plot containing the POL pairs for all times in cycle for both COLSS and CPC. These plots will show the ASI dependence of the NGF CHF correlations most clearly. It is expected that the dependence will have the form of two separate pools of data, one for the ASI region more negative than approximately +0.2 and one for the ASI region more positive than approximately +0.4. The ASI ranges for the two pools of data and the transition region are determined from these plots.

The composite plot with both COLSS and CPC data is expected to show that the COLSS data is effectively within the spread of the CPC data. In this case, the breakpoints and transition region for COLSS will be the same as those for CPC within the COLSS ASI range.

Since the mixing grids in the NGF design are in the top approximately 2/3 of the core and the mixing grids and the WSSV-T CHF correlation will provide a significant improvement in DNB performance, the relative percent difference in POL will be [ ]^{a,c} for the more positive ASI range (bottom peaked shapes) and [ ]^{a,c} for the more negative ASI range (center and top peaked shapes). [

]^{a,c} The composite plot containing data from both COLSS and CPC should yield the most conservative breakpoints. After analyzing several cycles of data, generic ASI ranges may be identified and simply verified for each cycle in this step of the analysis.

Step 5: Rerun the CPC MSCU analyses at each time in cycle using the limiting 1/64th hypercube of temperature, pressure and flow ranges determined in Step 3 over the full ASI range [

]^{a,c}

Step 6: For each time in cycle, use the F-Test, the Two Sample T-Test and the Wilcoxon Rank Sum Test to determine if the two separate sets of CPC data created in Step 5 are poolable. The F-Test examines variances of the two sets of data to see if they are significantly different. The Two Sample T-Test examines means using pooled estimates of the variance to see if they are close enough to conclude that they could have come from the same parent population. Both of these tests are valid for normal or near-normal distributions. The Wilcoxon Rank Sum Test assesses poolability for both normal and non-normal distributions.

[

]a,c

Step 7: Tabulate the BERR1 values for the [ ]a,c ASI ranges identified in Step 4 and the [ ]a,c ASI range set at each time in cycle. Compare the BERR1 values for the [ ]a,c ASI ranges at each time in cycle and [

]a,c

Calculate CPC and COLSS database constants that bound the necessary [

]a,c Constants that should bound future cycles will be used to avoid unnecessary changes in database constants.

Step 8: Repeat the COLSS and CPC MSCU analyses for the [

]a,c

The on-line COLSS and CPC algorithms [

]a,c while still maintaining the 95/95 probability/confidence level of the calculations which determine alarms and trips.

BERR1 and EPOL2/4 are uncertainty-related DNBR POL adjustment factors which can be either penalties or credits. [

]^{a,c}

2.5 Sample Analysis

The computer code and process modifications were tested using a preliminary analysis of [
]^{a,c} This section provides sample results from that analysis in order to illustrate the various steps in the process.

Step 1: Sample raw results of the standard MSCU analysis over the entire range of temperature, pressure, flow and ASI are shown in Table 1. Results for both COLSS (EPOL2/4) and CPC (BERR1) over the ranges shown in Table 2 are presented.

Step 2: Plots of DNB POL error for COLSS and CPC as a function of temperature, pressure and flow (mass flux) are shown in Figures 10 through 15.

Step 3: Correlation coefficients for each parameter at each time in cycle for both COLSS and CPC, consistent with the figures from Step 2, are shown in Table 3.

Based on these results, it is concluded that DNB POL for both COLSS and CPC is correlated to temperature and pressure but not to flow. Therefore, the most limiting one-quarter of the temperature and pressure ranges must be identified.

All cases were rerun over the entire flow and ASI range with the two extreme one-quarter of the temperature and pressure ranges as shown in Table 4. The raw results for both COLSS (EPOL2/4) and CPC (BERR1) are shown in Table 5. [

]^{a,c} Thus, this set of ranges will be chosen as the 1/64th hypercube.

[

]^{a,c}

Step 4: [

]^{a,c}

The breakpoints for the two pools of data and the transition region for CPC were determined by inspection of these plots. In particular, Figures 18 and 20, [

]^{a,c} These breakpoints are the most conservative choices, i.e. the least positive ASI range for the transition region between the two pools of data.

[

]^{a,c}

Step 5: Raw BERR1 results from the MSCU analysis at each time in cycle using the limiting 1/64th hypercube of temperature, pressure and flow ranges determined in Step 3 [
]^{a,c} identified in Step 4 are shown in Table 7.

Step 6: [
]^{a,c}

Step 7: [
]^{a,c} used to determine COLSS and CPC database constants are shown in Figure 21.

Step 8: Raw CPC BERR1 results for the [ ]^{a,c} at each time in cycle with the adjustment factor vs ASI applied are shown in Table 8. Similar results for COLSS EPOL2/4 are shown in Table 9, except that the values for the [
]^{a,c} Limiting values, which are used in the remainder of the MSCU analysis, are highlighted in bold.

3.0 Conclusions

The MSCU methodology described and approved in Reference 1 has the flexibility to address cores with CE 16x16 NGF. The COLSS and CPCS setpoint analyses which use the MSCU methodology will incorporate the NGF design, input data and CHF correlations in the CETOP-D calculations. The MSCU process has been modified to address ASI dependence and temperature, pressure or flow correlations.

The overall uncertainty factors determined using the MSCU methodology described in Reference 1 and the MSCU process steps described herein ensure that the COLSS DNB POL calculations and the CPCS DNBR calculations will be conservative to at least a 95% probability and 95% confidence level.

4.0 References

1. CEN-356(V)-P-A Revision 01-P-A, "Modified Statistical Combination of Uncertainties," May 1988.
2. CEN-305-P Revision 02-P, "Functional Design Requirements for a Core Protection Calculator," May 1988.*
3. CEN-304-P Revision 02-P, "Functional Design Requirement for a Control Element Assembly Calculator," May 1988.*
4. CEN-312-P Revision 02-P, "Overview Description of the Core Operating Limit Supervisory System (COLSS)," November 1990.*
5. CEN-160(S)-P Revision 1-P, "CETOP-D Code Structure and Modeling Methods for San Onofre Nuclear Generating Station Units 2 and 3," September 1981.*
6. CENPD-162-P-A, "C-E Critical Heat Flux," September 1976; Supplement 1-A, February 1977.
7. CENPD-207-P-A, "C-E Critical Heat Flux Part 2 Nonuniform Axial Power Distribution," December 1984.
8. CENPD-387-P-A Revision 000, "ABB Critical Heat Flux Correlations for PWR Fuel," May 2000.
9. WCAP-16523-P-A, "Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes," August 2007.
10. CENPD-170-P, "Assessment of the Accuracy of PWR Safety System Actuation as Performed by the Core Protection Calculators (CPC)," July 1975; Supplement 1-P, November 1975.
11. CEN-139(A)-P, "Statistical Combination of Uncertainties," November 1980. [Also, CEN-283(S)-P, October 1984; CEN-338(C)-P, August 1986; CEN-343(C)-P, October 1986.]
12. WCAP-16500-P-A Revision 0, "CE 16 x 16 Next Generation Fuel Core Reference Report," August 2007.
13. CENPD-161-P-A, "TORC Code - A Computer Code for Determining the Thermal Margin of a Reactor Core," April 1986.
14. A. Hald, "Statistical Theory with Engineering Applications," John Wiley & Sons, Inc., New York, 1952.

* References 2 through 5 were submitted to the NRC for information in order to aid in the review of other documents or plant specific submittals. Reference 5 is a plant specific document which is typical of similar documents for other plants. Changes have been made to CPC, CEAC, COLSS and CETOP-D since these documents were written. However, the general description of the systems and codes remains applicable.

GLOSSARY

Acronym/Abbreviation	Definition
ABB-NV	Critical heat flux correlation for non-vaned fuel
ANC	Westinghouse neutronics computer code
ANO-2	Arkansas Nuclear One Unit 2
ASI	Axial shape index [(L-U)/(L+U)] where L = power in lower axial half of the core & U = power in upper axial half of the core
BERR1	CPC addressable constant - multiplicative power adjustment factor for DNBR
CEAC	Control Element Assembly Calculator
CE-1	CE CHF correlation present in on-line algorithms
CETOP-D	Thermal margin algorithm and computer code
CHF	Critical Heat Flux
COLSS	Core Operating Limit Supervisory System
COSMO	Old design thermal hydraulics code
CPC	Core Protection Calculator
CPCS	Core Protection Calculator System
CPCTH	DNBR algorithm in original CPCS design
DNB	Departure from Nucleate Boiling
DNBOPM	DNB Overpower Margin
DNBR	Departure from Nucleate Boiling Ratio
E1, E2	CPC region-dependent algorithm uncertainty allowances for DNBR
EPOL (EPOL2, EPOL4)	COLSS DNB POL addressable constant adjustment factors
FLAIR	Old three-dimensional neutronics code
FSAR	Final Safety Analysis Report
INCA	Old power distribution measurement computer code
LHR	Linear Heat Rate
LPD	Local Power Density
MSCU	Modified Statistical Combination of Uncertainties
NGF	Next Generation Fuel
OPM	Over Power Margin
pdf	Probability Density Function
POL	Power Operating Limit
PVNGS	Palo Verde Nuclear Generating Station
RCS	Reactor Coolant System
ROCS	CE neutronics computer code
RPS	Reactor Protection System
SCU	Statistical Combination of Uncertainties
SER	Safety Evaluation Report
SONGS-2	San Onofre Nuclear Generating Station Unit 2
TIC (or TIL)	Time in Cycle or Time in Life (used interchangeably)
TORC	Detailed design thermal hydraulics code
WSSV-T	NGF CHF correlation for side supported mixing vaned fuel

Table 1: Sample Raw DNB-related Results (Step 1)

[ ]a,c

Table 2: Full Analysis Ranges for Step 1

[ ]a,c

Table 3: Sample Table of Correlation Coefficients

[ ] a,c

Table 4: Sample 1/64th Hypercube Ranges

[ ] a,c

Table 5: Sample Results for 1/64th Hypercube Ranges

[ ]a,c

Table 6: Sample Correlation Coefficients for 1/64th Hypercube

[ ]a,c

Table 7: Sample Raw BERR1 Results

a,c

Table 8: Sample CPC Results

a,c

Table 9: Sample COLSS Results

a,c

Figure 1: Modified Statistical Combination of Uncertainties Process
(As documented and approved in CEN-356(V)-P-A Revision 1-P-A)

a,c

Figure 2: CETOP-D POL Ratio vs ASI

a, c

Figure 3: CETOP-D POL Ratio vs ASI with NGF p.d.f.

a, c

[ ]

Figure 4: DNB POL Uncertainty vs CETOP-D Pressure

a, c

Figure 5: DNB POL Uncertainty vs CETOP-D Pressure

a, c

Figure 6: DNB POL Uncertainty vs CETOP-D Temperature

a, c

Figure 7: DNB POL Uncertainty vs CETOP-D Temperature

a, c

Figure 8: DNB POL Uncertainty vs CETOP-D Flow

a, c

Figure 9: DNB POL Uncertainty vs CETOP-D Flow

a, c

Figure 10: Sample COLSS POL Error vs Temperature

a, c

Figure 11: Sample CPC POL Error vs Temperature

a, c

Figure 12: Sample COLSS POL Error vs Pressure

a, c

Figure 13: Sample CPC POL Error vs Pressure

a, c

Figure 14: Sample COLSS POL Error vs Flow (Mass Flux)

a, c

[ ]

Figure 15: Sample CPC POL Error vs Flow (Mass Flux)

a, c

[ ]

Figure 16: Sample "Perfect CPC" POL Error vs ASI (Single TIC)

a, c

[ ]

Figure 17: Sample "Perfect COLSS" POL Error vs ASI (Single TIC)

a, c

Figure 18: Sample "Perfect CPC" POL Error vs ASI (All TIC)

a, c

Figure 19: Sample "Perfect COLSS" POL Error vs ASI (All TIC)

a, c

Figure 20: Sample "Perfect COLSS & CPC" POL Error vs ASI (All TIC)

a, c

Figure 21: Sample ASI Dependent Adjustment Factors

a, c

Section D

Westinghouse

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Our ref: LTR-NRC-09-44
August 21, 2009

Subject: Response to the NRC's Request for Additional Information by the Office of Nuclear Reactor Regulation for Topical Report (TR) WCAP-16500-P Supplement 1 Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)" (TAC No. ME0143) (Proprietary/Non-Proprietary)

Enclosed are copies of the Proprietary and Non-Proprietary versions of the responses to the NRC's Request for Additional Information by the Office of Nuclear Reactor Regulation for Topical Report (TR) WCAP-16500-P Supplement 1 Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)."

Also enclosed is:

1. One (1) copy of the Application for Withholding, AW-09-2654 (Non-proprietary) with Proprietary Information Notice.
2. One (1) copy of Affidavit (Non-proprietary).

This submittal contains proprietary information of Westinghouse Electric Company, LLC. In conformance with the requirements of 10 CFR Section 2.390, as amended, of the Commission's regulations, we are enclosing with this submittal an Application for Withholding Proprietary Information from Public Disclosure and an Affidavit. The Affidavit sets forth the basis on which the information identified as proprietary may be withheld from public disclosure by the Commission.

Correspondence with respect to the Affidavit or Application for Withholding should reference AW-09-2654 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

R. M. Span/FOR

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Enclosures
cc: G. Bacuta, NRR
P. Clifford, NRR

Westinghouse

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Our ref: AW-09-2654
August 21, 2009

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: LTR-NRC-09-44 P-Enclosure, "Response to the NRC's Request for Additional Information by the Office of Nuclear Reactor Regulation for Topical Report (TR) WCAP-16500-P Supplement 1 Revision 1, 'Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)' (TAC No. ME0143)" (Proprietary)

Reference: Letter from J. A. Gresham to Document Control Desk, LTR-NRC-09-44, dated August 21, 2009

The Application for Withholding Proprietary Information from Public Disclosure is submitted by Westinghouse Electric Company LLC (Westinghouse) pursuant to the provisions of paragraph (b)(1) of Section 2.390 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10 CFR Section 2.390, Affidavit AW-09-2654 accompanies this application for withholding, setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

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

Correspondence with respect to this application for withholding or the accompanying Affidavit should reference AW-09-2654 and should be addressed to J. A. Gresham, Manager of Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P. O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

R. M. Span / FOR

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Cc: G. Bacuta, NRR
P. Clifford, NRR

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared R. M. Span, 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:

R. M. Span

R. M. Span, Principal Engineer
Regulatory Compliance and Plant Licensing

Sworn to and subscribed
before me this 21st day
of August, 2009.

Sharon L. Markle

Notary Public

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Sharon L. Markle, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Jan. 29, 2011
Member, Pennsylvania Association of Notaries

(1) I am Principal Engineer, Regulatory Compliance and Plant Licensing, 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 rulemaking 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" 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 which 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 LTR-NRC-09-44 P-Enclosure, "Response to the NRC's Request for Additional Information by the Office of Nuclear Reactor Regulation for Topical Report (TR) WCAP-16500-P Supplement 1 Revision 1, 'Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)' (TAC No. ME0143)" (Proprietary), for submittal to the Commission, being transmitted by Westinghouse letter (LTR-NRC-09-44) and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk. The proprietary information as submitted by Westinghouse Electric Company includes responses to NRC request for additional information.

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

(a) Clarify the application of CE setpoint methodology for CE 16x16 NGF
(b) Assist customers in implementing an improved methodology.

Further this information has substantial commercial value as follows:

(a) Westinghouse can use the CE 16x16 NGF fuel design with associated setpoint methodology to further enhance their licensing position over their competitors.
(b) Assist customers to obtain license changes

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 fuel design 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.

Response to NRC's Request for Additional Information by the Office of Nuclear Reactor Regulation for Topical Report (TR) WCAP-16500-P Supplement 1 Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)" (TAC No. ME0143) (Non-Proprietary)

Westinghouse Electric Company
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NRC RAI 1

In the proposed setpoint methodology, [

]

Please calculate new addressable constants with these updated code versions and complete a thermal margin assessment. Provide the thermal margin assessment at several nominal operating points as well as top peaked and bottom peaked axial power distributions. Compare these thermal margins to identical state points generated using the proposed approach. The U.S. Nuclear Regulatory Commission (NRC) requests this work to assess the overall conservatism of the proposed approach and recognizes that updated versions of the COLSIM and CPCSIM codes do not need to include a proper verification and validation.

Westinghouse Response to NRC RAI 1

The WSSV-T and ABB-NV CHF correlations are [ ]^{a,c} Therefore, implementing these correlations into the COLSIM and CPCSIM codes is very difficult. The methodology to implement the Next Generation Fuel (NGF) correlations into the on-line COLSS or CPC, if possible, would be to [ ]^{a,c} similar to the approach used for BEACON-COLSS (see WCAP-12472-P Addendum 3-A) rather than modifying the current thermal hydraulic algorithms. Therefore, Westinghouse would like to propose an alternative approach to respond to this question. Instead of implementing the NGF correlations into the current thermal hydraulics algorithms in COLSIM and CPCSIM, [ ]^{a,c} This can be completed in approximately 2 months starting in January 2010.

NRC RAI 2

In the proposed setpoint methodology, an acceptance criterion of [ ] on the DNB power operating limit (POL) error is used to assess whether to perform the modified statistical combination of uncertainties (MSCU) within a limited range of temperature, pressure, and mass flux (i.e., hypercube). Please describe the basis for this acceptance criterion.

Westinghouse Response to NRC RAI 2

The choice of [ ]^{a,c} as an acceptance criterion on the correlation of the DNB POL error is explained in the second paragraph of Step 3 of Section 2.4 as follows:

[

]^{a,c}

A correlation value will be considered statistically significant if the absolute value is greater than [ ]^{a,c}. However, a correlation that is statistically significant may not have any practical significance as discussed above for the correlation acceptance criterion of [ ]^{a,c}. From A. Hald, "Statistical Theory with Engineering Applications," 1952, Section 19.12, equation 19.12.3,

$$t = \frac{r}{\sqrt{1-r^2}}\sqrt{f}$$

where r is a sample correlation value and f is equal to (sample size − 2). The sample size is the number of CETOP-D cases, ranging from about [

]^{a,c}

NRC RAI 3

Both within the current setpoint methodology and transient analyses, CETOP-D/detailed design thermal hydraulics code (TORC) correction factors are used to adjust CETOP-D departure from nucleate boiling ratio (DNBR) and DNBOPM predictions based upon the more detailed 3-dimensional open channel TORC model predictions. It is understood that the CETOP-D model has been updated to include the ABB-NV and WSSV-T CHF correlations. However, CETOP-D/TORC corrections factors may be sensitive to axial power distributions (such that separate factors may be required for top-peaked versus bottom-peaked axial power distributions). Furthermore, within a given ASI range, the correction factors may have different sensitivities to pressure, temperature, and mass flux. In addition, sensitivity between the two CHF correlations to assembly radial power distribution may also exist. Please describe how CETOP-D/TORC correction factors will be handled within the proposed setpoint process and for transient analyses for reload cores with CE16NGF assemblies.

Westinghouse Response to NRC RAI 3

The NGF CHF correlations, ABB-NV and WSSV-T, have been implemented in both the CETOP-D and TORC codes. **[**

][a,c]

NRC RAI 4

Section 2.4 of WCAP-16500-P Supplement 1 Revision 1 describes the use of core protection calculator (CPC) constants [

]

Please describe the historical basis for the current values of E1 and E2, describe how these values are credited in transient analyses, and provide calculated values for the sample [ ] analysis.

Westinghouse Response to NRC RAI 4

[

]a,c The definitions and use of E1 and E2 are described in CEN-305-P Revision 02-P (Functional Design Requirements for a Core Protection Calculator, May 1988) Sections 4.4.4 and 4.4.5.

Since E1 is in the reload data block (RDB), its value must be chosen before addressable constants, including BERR1, are calculated since [

]a,c Also, cycle independent values for E1 and E2 are preferred so that the RDB constants don't change for future cycles. [

]a,c

NRC RAI 5

The sample [ ] analysis highlights the extent of the [ ] The DNB POL error within the transition region will depend on the characteristics of the axial power distribution relative to the axial height of the first mixing vane. For instance, two axial power distributions with the same ASI value may exhibit significantly different DNB POL errors. In Figure 20 of WCAP-16500-P Supplement 1 Revision 1, calculated [ ] In light of this variability, please provide further justification for the selection of ASI breakpoints and use of a linear function in the core operating limit supervisory system (COLSS) and core protection calculator system (CPCS) database constants.

Westinghouse Response to NRC RAI 5

The final linear ASI dependent functions for CPC and COLSS will be chosen to bound any expected non-linearity between the breakpoints and the variation in the DNB POL error with time in cycle. [ ]^{a,c} The final uncertainty analysis runs using the MSCU methodology will determine the BERR1 and EPOL2/4 addressable constant values based on the chosen functions. Therefore, BERR1 and EPOL2/4 will compensate for any points where the ASI dependent functions are non-conservative due to unexpected non-linearity.

Step 8 of the process repeats the CPC and COLSS overall uncertainty analyses with the [ ]^{a,c} Tables 8 and 9 of the topical supplement revision show sample results from this step. [ ]^{a,c} This assures that the combination of the addressable constants and the ASI dependent adjustments yield conservative results over the entire ASI range. This conclusion is valid even if the ASI breakpoints chosen in Step 4 are not exact for a given time in cycle. Further examples of this process were provided in an audit performed by the NRC on August 12, 2009.

[ ]^{a,c}

[

]a,c

NRC RAI 6

Due to burnup effects on power distribution, the number of MSCU cases within any given ASI range varies with time-in-life. Are there a minimum number of cases which must exist for each ASI range to ensure a statistically significant population?

Westinghouse Response to NRC RAI 6

[

]a,c This assures a reasonable distribution of cases throughout the COLSS or CPC ASI range. The revised process provides an indication of the distribution of cases vs ASI so that the analyst can assure that the cases are distributed reasonably. If a poor distribution is identified for any reason, the case set will be adjusted to compensate. It is not expected to occur as a result of NGF since mixing grids and CHF correlations do not affect the axial shape directly. Axial shape characteristics are primarily a function of fuel and poison design and the pattern of fresh and burned fuel. However, the process has the capability of detecting a significant maldistribution of cases vs ASI.

[

]a,c

Section E

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LTR-NRC-10-14

March 9, 2010

Subject: Addendum 1 to WCAP-16500-P Supplement 1 Revision 1/WCAP-16500-NP Supplement 1 Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF) (Follow-up Response to NRC RAI #1)" (Proprietary/Non-Proprietary)

Reference: Letter from J. A. Gresham (Westinghouse) to USNRC Document Control Desk, "Follow-up Response to NRC RAI #1 for WCAP-16500-P Supplement 1 Revision 1, 'Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)' (Proprietary/Non-Proprietary)," LTR-NRC-10-6, February 9, 2010.

Enclosed are copies of the Proprietary and Non-Proprietary versions of Addendum 1 to WCAP-16500-P Supplement 1 Revision 1/WCAP-16500-NP Supplement 1 Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF) (Follow-up Response to NRC RAI #1)." The follow-up response is being provided as an Addendum per request from the NRC Project Manager and replaces the above reference.

The NRC Final Safety Evaluation for Westinghouse Electric Company Topical Report WCAP-16500-P, Supplement 1, Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF)" dated December 28, 2009, contained the following condition and limitation:

> Until Westinghouse provides an acceptable written response to RAI #1, an interim margin penalty of 3.0 percent must be applied to the final addressable constants (e.g., BERR1* 1.03, [(1+EPOL2)*1.03 - 1.0]) calculated following the analytical steps defined in WCAP-16500-P, Supplement 1, Revision 1.

The enclosed follow-up response to RAI #1 addresses the SE condition and limitation. It is requested that the NRC provide Westinghouse with a letter confirming that the Condition and Limitation of the WCAP-16500-P Supplement 1 Revision 1 SE has been met and the interim 3.0 percent penalty is no longer required.

Also enclosed is:

1. One (1) copy of the Application for Withholding Proprietary Information from Public Disclosure, AW-10-2772 (Non-Proprietary) with Proprietary Information Notice and Copyright Notice.
2. One (1) copy of Affidavit (Non-Proprietary).

This submittal contains proprietary information of Westinghouse Electric Company LLC. In conformance with the requirements of 10 CFR Section 2.390, as amended, of the Commission's regulations, we are enclosing with this submittal an Application for Withholding Proprietary Information from Public Disclosure and an Affidavit. The affidavit sets forth the basis on which the information identified as proprietary may be withheld from public disclosure by the Commission.

Correspondence with respect to the application for withholding or the Westinghouse affidavit should reference AW-10-2772 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

R.M. Span/FOR

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

Enclosures

cc: E. Lenning, NRR
P. Clifford, NRR

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AW-10-2772

March 9, 2010

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: Addendum 1 to WCAP-16500-P Supplement 1 Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF) (Follow-up Response to NRC RAI #1)" (Proprietary)

Reference: Letter from J. A. Gresham to USNRC Document Control Desk, LTR-NRC-10 14, dated March 9, 2010

The Application for Withholding Proprietary Information from Public Disclosure is submitted by Westinghouse Electric Company LLC (Westinghouse), pursuant to the provisions of paragraph (b)(1) of Section 2.390 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10 CFR Section 2.390, Affidavit AW-10-2772 accompanies this application for withholding, setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

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

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-10-2772 and should be addressed to J. A. Gresham, Manager, Regulatory Compliance and Plant Licensing, Westinghouse Electric Company LLC, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

R. M. Span / FOR

J. A. Gresham, Manager
Regulatory Compliance and Plant Licensing

cc: E. Lenning, NRR
P. Clifford, NRR

AW-10-2772

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared R. M. Span, 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:

R. M. Span, Principal Engineer
Regulatory Compliance and Plant Licensing

Sworn to and subscribed before me
this 9th day of March 2010

Notary Public

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
Renee Giampole, Notary Public
Penn Township, Westmoreland County
My Commission Expires September 25, 2013

(1) I am Principal Engineer, Regulatory Compliance and Plant Licensing, 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 Addendum 1 to WCAP-16500-P Supplement 1 Revision 1, "Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF) (Follow-up Response to NRC RAI #1)" (Proprietary), for submittal to the Commission, being transmitted by Westinghouse letter, LTR-NRC-10-14, 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 a follow-up response to NRC request for additional information, and may be used only for that purpose.

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

(a) Clarify the application of CE setpoint methodology for CE 16x16 NGF.

(b) Assist customers in implementing an improved methodology.

Further this information has substantial commercial value as follows:

(a) Westinghouse can use the CE 16x16 NGF fuel design with associated setpoint methodology to further enhance their licensing position over their competitors.

(b) Assist customers to obtain license changes.

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 methodology 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.

NRC RAI #1

In the proposed setpoint methodology, [

] Please calculate new addressable constants with these updated code versions and complete a thermal margin assessment. Provide the thermal margin assessment at several nominal operating points as well as top peaked and bottom peaked axial power distributions. Compare these thermal margins to identical state points generated using the proposed approach. The U.S. Nuclear Regulatory Commission (NRC) requests this work to assess the overall conservatism of the proposed approach and recognizes that updated versions of the COLSIM and CPCSIM codes do not need to include a proper verification and validation.

Westinghouse Follow-up Response to NRC RAI #1

The WSSV-T and ABB-NV CHF correlations are [ ]^{a,c} Therefore, implementing these correlations into the COLSIM and CPCSIM codes is very difficult. Therefore, instead of implementing the NGF correlations into the current thermal hydraulics algorithms in COLSIM and CPCSIM, Westinghouse has [ ]^{a,c} These modified codes were used to calculate new addressable constants and determine thermal margin for various time points over the most recent cycles of [ ]^{a,c} as well as for several top peaked and bottom peaked axial power distributions.

Cycle minimum DNBR thermal margins are listed in Table 1. Detailed COLSS time in cycle nominal ASI margin results are shown in Figure 1 and Figure 2. Detailed CPC time in cycle nominal ASI, top peaked and bottom peaked margin results are shown in Figure 3 and Figure 4. The values in Table 1 and the figures are based on cases selected to illustrate the relative margins of setpoints methods and do not necessarily represent actual plant margins. In fact, the cases which produce the minimum margins for positive and negative Axial Shape Index (ASI) are based on axial shapes near or beyond the ASI trip limits. Top peaked and bottom peaked calculations were not performed for COLSS since they would be outside the narrower COLSS ASI alarm limits.

The comparison of the results using the process described in WCAP-16500-P Supplement 1 Revision 1 (identified as 'WCAP') with the results using the [ ]^{a,c} (identified as 'RAI') shows that the WCAP process produces lower more conservative DNBR margins in each case. [ ]^{a,c}

These results demonstrate that the bias introduced by the proposed setpoint methodology is conservative and that the interim 3.0 percent penalty imposed by the Limitations and Conditions of the Safety Evaluation may be removed.

Table 1

Cycle Minimum DNBR Margins

a,c

Figure 1

[ ] a,c

Figure 2

[ ]a,c

Figure 3

[ ]a,c

Figure 4

[ ]a,c