AEP
INDIANA MICHIGAN POWER®
A unit of American Electric Power

Indiana Michigan Power
One Cook Place
Bridgman, MI 49106
IndianaMichiganPower.com

June 11, 2012

AEP-NRC-2012-38
10 CFR 50.46

Docket No.: 50-315
50-316

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

Donald C. Cook Nuclear Plant Units 1 and 2
Response to Request for Information
10 CFR 50.46 Report for Emergency Core Cooling System Model Change or Error Associated with Thermal Conductivity Degradation

References:

1. Letter from J. P. Gebbie, Indiana Michigan Power Company. to U. S. Nuclear Regulatory Commission Document Control Desk, "Response to Information Request Pursuant to 10 CFR 50.54(f) Related to the Estimated Effect on Peak Cladding Temperature Resulting from Thermal Conductivity Degradation in the Westinghouse-Furnished Realistic Emergency Core Cooling System Evaluation (TAC No. M99899)," dated March 19, 2012. ML12088A104

2. Letter from P. S. Tam, U. S. Nuclear Regulatory Commission to L. J. Weber, Indiana Michigan Power Company, "Donald C. Cook Nuclear Plant, Units 1 and 2 – Request for Additional Information on the Issue of Peak Cladding Temperature Affected by Thermal Conductivity Degradation (TAC Nos. ME8322 and ME8323," dated May 14, 2012, Agencywide Documents Access and Management System Accession Number ML12129A501

By Reference 1, Indiana Michigan Power Company (I&M), licensee for the Donald C. Cook Nuclear Plant Units 1 and 2 (CNP), submitted a response to a Nuclear Regulatory Commission (NRC) information request pursuant to Title 10 of the Code of Federal Regulations (10 CFR) 50.54(f) related to the estimated effect on peak cladding temperature resulting from thermal conductivity degradation (TCD) in the Westinghouse-furnished realistic emergency core cooling evaluation. I&M also stated that this response served as a 30-day report of a significant emergency core cooling system evaluation model change or error in accordance with requirements of 10 CFR 50.46(a)(3).

PROPRIETARY INFORMATION
Enclosure 1 to this letter contains proprietary information.
Withhold from public disclosure under 10 CFR 2.390.
Upon removal of Enclosure 1, this letter is decontrolled.

A002
NRR

In the course of its 10 CFR 50.46 report review, the NRC staff determined that additional information was necessary to complete its review. This request for additional information (RAI) was provided as Reference 2. This submittal provides I&M's response to the RAI.

The responses for RAIs 1, 2, 3, 4a-4f, 6, 7, 8 and 9 have been prepared by Westinghouse Electric Company LLC (WEC) and are included as Enclosure 1. Enclosure 1 contains information proprietary to WEC and is supported by Enclosure 2, an affidavit signed by WEC, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of Section 2.390 of the Commission's regulations. Accordingly, it is respectfully requested that the information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR 2.390 of the Commission's regulations. Enclosure 3 is a non-proprietary version of the information in Enclosure 1. Enclosure 4 is I&M's response to RAI 5.

There are no new or revised commitments in this letter. Should you have any questions, please contact Mr. Michael K. Scarpello, Regulatory Affairs Manager, at (269) 466-2649.

Sincerely,

Michael H. Carlson
Vice President Site Support Services

MCS/jmr

Enclosures:

1. WEC Response to RAIs (proprietary)
2. Affidavit
3. WEC Response to RAIs (non-proprietary)
4. Response to RAI 5

c: C. A. Casto, NRC Region III
J. T. King, MPSC
S. M. Krawec, AEP Ft. Wayne, w/o enclosure
MDEQ – RMD/RPS
NRC Resident Inspector
P. S. Tam, NRC Washington DC

ENCLOSURE 2 TO AEP-NRC-2012-38

Affidavit

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF BUTLER:

Before me, the undersigned authority, personally appeared J. A. Gresham, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

J. A. Gresham, Manager
Regulatory Compliance

Sworn to and subscribed before me
this 31st day of May 2012

Notary Public

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in AEP-12-53 P-Attachment, "D. C. Cook Units 1 and 2 – Response to NRC Formal Request for Additional Information (RAI) from the Reactor Systems Branch Related to the 10 CFR 50.46, 30-Day Report" (Proprietary) for submittal to the Commission, being transmitted by American Electric Power letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk. The proprietary information as submitted by Westinghouse is that associated with fuel thermal conductivity degradation, and may be used only for that purpose.

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

(a) Assist customers in providing responses to RAIs dealing with the 10 CFR 50.46, 30-day report.

Further this information has substantial commercial value as follows:

(a) Provide licensing support with respect to thermal conductivity degradation.

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

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar 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.

PROPRIETARY INFORMATION NOTICE

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

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

ENCLOSURE 3 TO AEP-NRC-2012-38

Thermal Conductivity Degradation
Response to Request for Additional Information (RAI)
(Non-Proprietary)

RAI 1
RAI 2
RAI 3
RAI 4a-4f
RAI 6
RAI 7
RAI 8
RAI 9

Documents referenced in this Enclosure will be provided upon request.

References to American Electric Power in this document are applicable to Indiana Michigan Power (I&M)

D. C. Cook Units 1 and 2 – Response to NRC Formal Request for Additional Information (RAI) from the Reactor Systems Branch Related to the 10 CFR 50.46, 30-Day Report

May 2012

NRC RAI 1

Provide a table of data that includes the following ASTRUM inputs for AOR and integrated analyses: (1) AOR Run #, (2) TCD Run #, (3) PCT, (4) Time of PCT, (5) Fq, (6) FdH, (7) Cycle Burnup, (8) RCS Tavg, (9) Accumulator Temperature, (10) Safety Injection Temperature, (11) Safety Injection Time.

Response

The requested tables of data are provided in Tables 1 and 2 (D. C. Cook Unit 1) and Tables 3 and 4 (D. C. Cook Unit 2).

Table 1: D. C. Cook Unit 1 (AEP) Integrated TCD Evaluation Runset Data

[ ]a,c

Table 2: D. C. Cook Unit 1 (AEP) AOR Runset Data

a,c

a,c

a,c

a,c

Table 3: D. C. Cook Unit 2 (AMP) Integrated TCD Evaluation Runset Data

[ ]a,c

[ ]a,c

Table 4: D. C. Cook Unit 2 (AMP) AOR Runset Data

a,c

[ ]a,c

a,c

a,c

a,c

NRC RAI 2

Please highlight the limiting cases in the ASTRUM run matrices and explain how these cases were chosen. Provide details and explain the approach used to estimate (1) the effects of TCD and (2) the compensating model changes. Justify the selection of the number of WCOBRA/TRAC cases that were re-executed, as opposed to a larger number of cases.

Response

The cases from the ASTRUM run matrices that were chosen to assess the effects of TCD are indicated in the response to *NRC RAI 1*.

[ ] a,c

The estimate of effect for the compensating model changes was provided by the difference between the AOR PCT and the Margin PCT. The estimate of effect of TCD was provided by the difference between the Integrated TCD PCT and the Margin PCT.

[ ] a,c

[ ] a,c

In this evaluation, engineering judgment was applied to select small run sets of limiting cases for the purpose of evaluating the effects of the design input margins and TCD on the D. C. Cook Units 1 and 2 large break LOCA PCT. The remaining cases from the ASTRUM AORs which were not explicitly evaluated are expected to remain non-limiting and therefore would not be expected to influence the PCT estimate. The evaluations of TCD and peaking factor burndown support the full life of the fuel operation.

Table 2-1: Run Selection for D. C. Cook Unit 1 TCD Evaluation

[ ] a,c

Table 2-2: Run Selection for D. C. Cook Unit 2 TCD Evaluation

[ ]a,c

NRC RAI 3

Justify the containment pressure changes made to obtain margin on Unit 1. Provide reference to excerpts from the applicable methodologies to clarify the response.

Response

The Unit 1 analysis of record (AOR) contained 'analysis margin' based on the difference between the LOTIC2 (Reference 1) calculated containment backpressure and the WCOBRA/TRAC containment backpressure input. In order to recapture this margin while still assuring a conservatively low containment backpressure, the LOTIC2 containment pressure response was calculated with the design input changes and the analysis margin was reduced. The design input changes have competing effects on the LOTIC2 calculated backpressure, which lead to a slightly lower calculated pressure early in the transient and a slightly higher calculated pressure late in the transient. The final WCOBRA/TRAC input used in the TCD evaluation was compared to the updated LOTIC2 calculated pressure consistent with Westinghouse BELOCA analysis guidance and is conservatively low (as required per Sections 11-3-1, 11-4-11 and 12-3-4 of WCAP-16009-P-A, Reference 2). This comparison is shown in Figure 1 of Enclosure 2 to AEP-NRC-2012-13 (Reference 3).

References

1. WCAP-8354-P-A, Supplement 1, "Long Term Ice Condenser Containment Code – LOTIC Code," April 1976. (Proprietary)
2. WCAP-16009-P-A, Revision 0, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment of Uncertainty Method (ASTRUM)," January 2005. (Proprietary)
3. AEP-NRC-2012-13, "Donald C. Cook Nuclear Plant Units 1 and 2, Response to Information Request Pursuant to 10 CFR 50.54(f) Related to the Estimated Effect on Peak Cladding Temperature Resulting from Thermal Conductivity Degradation in the Westinghouse-Furnished Realistic Emergency Core Cooling System Evaluation (TAC No. M99899)," March 19, 2012. (Available in NRC ADAMS database, accession number is ML12088A104)

NRC RAI 4a

The final paragraph on Page 2 of 9 refers to small differences in fuel characteristics that were claimed to be compared. The paragraph also discusses confirmatory evaluations concluding that other operating characteristics were acceptable. Provide the results of this comparison for D. C. Cook, including the relevant conclusions and the technical basis supporting those conclusions. For any conclusion regarding differences in void volume are offset by other conservatisms, list those conservatisms and provide a quantitative estimate of each conservatism, as well as a brief description of the rigor associated with that estimate.

Response

For the D. C. Cook Unit 1 IFBA rods, rod internal pressure and fuel temperatures were generated explicitly for the D. C. Cook Unit 1 core. For the D. C. Cook Unit 1 non-IFBA rods and D. C. Cook Unit 2 rods, the key fuel parameters used for fuel temperature analyses were compared to a TCD analysis of a representative rod type. [

]^{a,c} The specifics of the comparison for D. C. Cook Unit 1 and 2 are as follows:

a,c

[ ]a,c

NRC RAI 4b

Please provide the values for the coefficients used in the PAD 4.0 + TCD UO_2 thermal conductivity equation.

Response

The functional form used to model TCD [ ]a,c is as follows:

[ ]a,c

NRC RAI 4c

Please explain any error corrections, code improvements, and miscellaneous code cleanup between the WCOBRA/TRAC and HOTSPOT code versions used in the TCD evaluations and those used in the plant's AOR.

Response

The WCOBRA/TRAC and HOTSPOT code versions used in the evaluation of fuel pellet thermal conductivity degradation do not include any error corrections, code improvements, or model changes from the analysis-of-record code versions.

NRC RAI 4d

What is the thermal conductivity model impact of code version changes in HOTSPOT?

Response

Please refer to the response to *NRC RAI 4c* above.

NRC RAI 4e

Explain the differences between the HOTSPOT and PAD thermal conductivity models and the impact of those differences. Provide graphs or other quantified descriptions that aid in explanation.

Response

For the fuel thermal conductivity degradation (TCD) evaluation, PAD 4.0 TCD was used to generate the initial maximum fuel average temperature input into WCOBRA/TRAC and HOTSPOT. The PAD 4.0 TCD fuel thermal conductivity equation, for fuel at a nominal density of 95% theoretical density is given in LTR-NRC-12-27 (Reference 1) with the coefficients provided in response to part b) of this request for additional information (RAI) and repeated below.

[ ]a,c

For the TCD evaluation, WCOBRA/TRAC and HOTSPOT used a fuel thermal conductivity model based on [ ]a,c For fuel at a nominal density of 95% theoretical density, the model in WCOBRA/TRAC and HOTSPOT is given in LTR-NRC-12-27 (Reference 1) and repeated below.

[ ]a,c

The functional form and units between the two models are different. For ease of comparison, the degradation terms (*f(Bu)* in both equations) are compared in Figure 1 at burnups of 20, 40 and 65 GWD/MTU. As seen from Figure 1, [ ]a,c

Figures 2 through 5 compare the overall fuel thermal conductivity models at burnups of 0, 20, 40 and 65 GWD/MTU, respectively. Also included in the figures is a comparison with the FRAPCON 3.4 thermal conductivity model (Reference 2). As seen from the figures, [

]a,c

For a given maximum fuel average temperature and burnup, the differences between the PAD 4.0 TCD and WCOBRA/TRAC and HOTSPOT fuel thermal conductivity models [

]a,c

References

1. LTR-NRC-12-27, "Westinghouse Input Supporting Licensee Response to NRC 10 CFR 50.54(f) Letter Regarding Nuclear Fuel Thermal Conductivity Degradation (Proprietary/Non-Proprietary)," March 7, 2012.

2. NUREG/CR-7022, Vol. 1 / PNNL-19418, Vol.1, "FRAPCON-3.4: A Computer Code for the Calculation of Steady-State Thermal-Mechanical Behavior of Oxide Fuel Rods for High Burnup," March 2011.

3. WCAP-12945-P-A, Volume 1 (Revision 2) and Volumes 2 – 5 (Revision 1), "Code Qualification Document for Best Estimate LOCA Analysis," March 1998. (Proprietary)

4. WCAP-16009-P-A, Revision 0, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment Of Uncertainty Method (ASTRUM)," January 2005. (Proprietary)

Figure 1: Fuel Thermal Conductivity Degradation Model Comparison

[ ]a,c

Figure 2: Fuel Thermal Conductivity Model Comparisons – 0 GWD/MTU

[ ]a,c

Figure 3: Fuel Thermal Conductivity Model Comparisons – 20 GWD/MTU

a,c

Figure 4: Fuel Thermal Conductivity Model Comparisons – 40 GWD/MTU

a,c

Figure 5: Fuel Thermal Conductivity Model Comparisons – 65 GWD/MTU

[ ]a,c

NRC RAI 4f

Please provide additional detail concerning the steady-state ASTRUM/CQD initialization process. In particular, please explain what fuel characteristics are adjusted within the applicable models to obtain convergence among HOTSPOT, WCOBRA-TRAC, and PAD4.0 + TCD.

Response

The following parameters in WCOBRA/TRAC are used to determine steady-state convergence, as discussed in Section 20-5 of WCAP-12945-P-A (Reference 1) and Section 12-4-1 of WCAP-16009-P-A (Reference 2).

[ ]a,c

a,c

References

1. WCAP-12945-P-A, Volume 1 (Revision 2) and Volumes 2 – 5 (Revision 1), "Code Qualification Document for Best Estimate LOCA Analysis," March 1998. (Proprietary)

2. WCAP-16009-P-A, Revision 0, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment Of Uncertainty Method (ASTRUM)," January 2005. (Proprietary)

Table 1: Initial Gap Thickness and Average Fuel Temperature Comparison for Sample 17x17 Plant

[ ]a,c

Table 2: Initial Gap Thickness and Average Fuel Temperature Comparison for Sample 15x15 Plant

[ ]a,c

Table 3: HOTSPOT and WCOBRA/TRAC Steady-State Gap Heat Transfer Coefficient and Average Fuel Temperature Comparison for Sample 17x17 Plant

[ ] a,c

Table 4: HOTSPOT and WCOBRA/TRAC Steady-State Gap Heat Transfer Coefficient and Average Fuel Temperature Comparison for Sample 15x15 Plant

[ ] a,c

Figure 1: WCOBRA/TRAC and HOTSPOT Cladding Temperature Comparison for 17x17 Plant

[ ] a,c

Figure 2: WCOBRA/TRAC and HOTSPOT Cladding Temperature Comparison for 15x15 Plant

a,c

NRC RAI 6

Fully explain all peaking factor adjustments and provide the rationale for each adjustment.

Response

In order to support the Loss of Coolant Accident (LOCA) evaluation of thermal conductivity degradation (TCD) on the best estimate LOCA (BELOCA) analyses of record (AOR), Nuclear Design (ND) proposed peaking factor limits for D. C. Cook Unit 1 Cycle 24 (currently operating), Unit 2 Cycle 19 (past cycle), and Unit 2 Cycle 20 (currently operating). The LOCA group evaluated TCD with these proposed limits and demonstrated that the TCD objectives for both units were met. An additional 4% $F_{\Delta H}$ uncertainty was included in the base LOCA input and the treatment of the uncertainties in the evaluation was handled consistent with the ASTRUM methodology (Reference 1).

D. C. Cook Unit 1 Cycle 24 COLR

Peaking Factor	Pre-TCD	Post-TCD
F_Q	2.15	2.15
$F_{\Delta H}$	1.49	1.485

D. C. Cook Unit 2 Cycles 19 and 20 COLRs

Peaking Factor	Pre-TCD	Post-TCD
F_Q	2.335	2.335
$F_{\Delta H}$	1.58	1.548

The rationale for lowering the $F_{\Delta H}$ limit on both units was to fully take advantage of the available ND margin to support the LOCA TCD evaluations. Subsequent administrative controls as part of the implementation of the LOCA TCD evaluations include updates to the COLR documents.

Reference

1. WCAP-16009-P-A, Revision 0, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment Of Uncertainty Method (ASTRUM)," January 2005. (Proprietary)

NRC RAI 7

At the bottom of Page 1 of Enclosure 2 to AEP-NRC-2012-13 it is stated that, "I&M and WEC utilized processes which ensure that the LBLOCA [large-break loss-of-coolant accident] analysis input values conservatively bound the as-operated plant values for those parameters." Please explain these processes.

Response

American Electric Power and its vendor, Westinghouse Electric Company LLC, ensure the LOCA analysis input values conservatively bound the as-operated plant values for the relevant parameters via the fuel reload process. The purpose of the fuel reload process is to evaluate the plant changes resulting from the loading of different or new fuel into the core. As described in WCAP-9272-P-A (Reference 1), the evaluations performed for the fuel reload are reviewed in accordance with 10 CFR 50.59. The accident analyses-of-record are generally analyzed such that the relevant parameters are selected in a bounding direction compared to the expected operational values. In accordance with Reference 1, the fuel reload evaluation relies upon the bounding approach in which safety analyses are performed to accommodate the plant changes resulting from different or new fuel in the core without requiring new safety analyses.

As part of the reload evaluation, the LOCA analyst generates a list of important parameters to the LBLOCA analysis which show a fuel reload dependency, and identifies the values of those parameters supported by the LBLOCA licensing basis analyses and evaluations. The parameters are confirmed to support the reload core design or are evaluated with respect to the LBLOCA analysis.

Separate from the fuel reload process, plant changes which may impact the LBLOCA analysis are identified to Westinghouse as needed, and 10 CFR 50.46 evaluations are performed as necessary. During the reload process, a summary of plant changes that have occurred since the previous cycle and changes planned for the upcoming cycle is provided by American Electric Power to Westinghouse. Westinghouse reviews those changes identified by American Electric Power to ensure the non-reload related parameters analyzed in the LBLOCA analysis-remain applicable. For example, steam generator tube plugging level is one such non-reload related parameter reviewed as part of the reload analysis to ensure that the LBLOCA analysis remains applicable.

Reference

1. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985. (Proprietary)

NRC RAI 8

Please explain the process for determining the establishment of a trend in the context of the following statement: "For the margin PCT calculation, WCOBRA/TRAC cases were executed until an estimated trend could be established."

Response

For D. C. Cook Unit 1, [

]a,c

For D. C. Cook Unit 2, [

]a,c

NRC RAI 9

Based on the NRC's review of the March 19, 2012, submittal it appears that the licensee has revised inputs to a method of evaluation as described in the Final Safety Analysis Report (as updated) used in establishing the design bases or in the safety analyses.

Revision 1 to NEI 96-07, "Guidelines for 10 CFR 50.59 Implementation," Section 3.8, "Input Parameters," (Accession No. ML003771157) provides clarifying information concerning whether an input parameter is considered to be an element of a methodology for the purposes of addressing the applicable requirements found at Title 10 of the Code of Federal Regulations (10 CFR) 50.59, "Changes, Tests, and Experiments." Address whether the methodology permits the licensee to establish how to select the value of an input parameter to yield adequately conservative results and whether the revised value is more conservative than that required by the selection method.

Address whether any of the changes (i.e., to the UO2 thermal conductivity equation) constitutes a change in the calculational framework used for evaluating behavior or response of a system, structure or component. Explain whether and how 10 CFR 50.59(c)(4) might apply to such a change.

Response

Westinghouse currently employs three best estimate Evaluation Model (EM) methodologies for analysis of the large break loss-of-coolant accidents (LBLOCA) in pressurized water reactors (PWRs):

- 1996 Westinghouse Best Estimate LBLOCA Evaluation Model (Code Qualification Document (CQD) EM, Reference 1)
- 1999 Westinghouse Best Estimate LBLOCA Evaluation Model, Application to PWRs (Pressurized Water Reactors) with Upper Plenum Injection (CQD-UPI EM, Reference 2)
- 2004 Westinghouse Realistic LBLOCA Evaluation Model using ASTRUM (Automated Statistical Treatment of Uncertainty Method) (ASTRUM EM, Reference 3)

In application of a Westinghouse best estimate large break LOCA methodology to a plant analysis, Westinghouse works with the licensee to establish several parameter values input to the specific analysis per the Nuclear Regulatory Commission (NRC) – approved evaluation model requirements (including applicability restrictions specified by the NRC in their Safety Evaluation Reports (SERs)). The licensee is permitted to establish the values of these parameters on the basis of plant-specific considerations; as such they are input to the methodology and not part of the methodology, as defined in NEI 96-07 Revision 1 (Reference 6) Section 3.8. The input parameter values may be selected conservatively in order to support current plant operation, as well as accommodate expected future changes or otherwise at the discretion of the licensee. Table 1 summarizes the selected design input changes evaluated in conjunction with the execution of the thermal conductivity degradation (TCD) evaluation(s) performed as described in the Reference 7 submittal, and relevant governing topical report references identifying how these values are to be selected.

In the evaluations of design input changes performed as described in the Reference 7 submittal, the changes to design input values were made to more closely represent current plant operation. Selection of the revised input parameter values was made in accordance with the approved EM. Therefore, the design input changes reflect reduction in the conservatism of these values and are considered an input parameter change and not a change to the methodology, consistent with Reference 6 Section 3.8.

Westinghouse and its licensees utilize processes which ensure that the LBLOCA analysis input values conservatively bound the as-operated plant values for these parameters.

In the evaluations of TCD and design input changes for D. C. Cook Unit 1, as described in the Reference 7 submittal, analysis input conservatism in the containment pressure input was reduced in order to recover peak cladding temperature (PCT) margin. The as-approved ASTRUM EM specifies that a conservative containment backpressure will be used. The degree of conservatism is not specifically defined by the EM or constrained by the NRC SER. The magnitude of the conservatism may vary between analyses due to different plant operating parameter ranges considered in each analysis (such as steam generator tube plugging and vessel average temperature), different licensee requirements to accommodate expected containment changes, and/or different engineering judgment during the analysis execution regarding the need to reduce the input conservatism and recover associated PCT margin in the analysis. This discretionary input parameter conservatism may be recovered while remaining in accordance with the as-approved EM.

This type of analysis conservatism in the containment backpressure input was not evaluated for D. C. Cook Unit 2.

Fuel pellet TCD and peaking factor burndown were not explicitly considered in the as-approved Westinghouse best estimate LBLOCA EMs. In order to evaluate the PCT effect of TCD and peaking factor burndown as described in the Reference 7 submittal, evaluation techniques were used that are outside of the as-approved EMs. This was necessary to explicitly consider the fuel performance effects of TCD, and to adequately evaluate the burnup-dependent aspects of the fuel performance changes considering TCD. Specifically, the following aspects of the TCD evaluation(s) were outside of the as-approved best estimate LBLOCA EM:

[ ] a,c

10 CFR 50.46 establishes criteria for reporting and for action regarding changes or errors involving methods for loss of coolant analyses. For the evaluation and reporting of PCT impact, the changes to the LBLOCA EM to explicitly consider the fuel performance effects of TCD and to adequately evaluate the burnup-dependent aspects of the fuel performance are governed by 10 CFR 50.46. Consistent with

10 CFR 50.59(c)(4) and Reference 6 Section 4.1.1, the provisions of 10 CFR 50.59 do not apply for the LBLOCA EM changes for evaluations and reporting of PCT impact because the 10 CFR 50.46 regulation establishes more specific criteria for reporting and for action for changes involving methods for loss of coolant accidents.

In summary, in the evaluations of TCD and design input changes as described in the Reference 7 submittal, two types of changes were made:

- Design input values were changed to more closely represent plant operation, or analysis input changes were made to reduce conservatism in as-analyzed values. The licensee is permitted to establish the value of these parameters on the basis of plant-specific considerations; as such these are changes to the input of the methodology and are not part of the methodology. Therefore, the design input changes reflect reduction in the conservatism of these values and are considered an input parameter change and not a change to the methodology.
- Techniques to appropriately account for the burnup-dependent effects of TCD were used in the evaluation(s) which are outside of the as-approved EMs. These changes to the calculational framework (as defined in 10 CFR 50.46(c)(2)) were required to assess the TCD phenomena which are not explicitly accounted for in the as-approved EMs. The provisions of 10 CFR 50.59 do not apply for the LBLOCA EM changes for evaluations and reporting of PCT impact because the 10 CFR 50.46 regulation establishes more specific criteria for reporting and for action for changes involving methods for loss of coolant accidents.

Table 1: Applicable Evaluation Model Reference(s) for Selection of the Design Input Parameters Modified in TCD Evaluations for D. C. Cook Units 1&2

Design Input Change (1)	Relevant Section(s) of ASTRUM Topical Report (Reference 3)
Specification of peaking factors	Section 1-2-11 Table 1-10
Steam generator tube plugging range	Section 1-2-11 Section 11-3-1
Containment pressure input (2)	Section 11-3-1 Section 11-4-11 Section 12-3-4
Vessel average temperature range	Section 1-2-11 Table 1-11
Accumulator water temperature range	Section 1-2-11 Table 1-11 Section 13-3
Refueling Water Storage Tank (RWST) water temperature range (3)	Section 1-2-11 Table 1-11 Section 13-3
Safety Injection (SI) delay time	Section 12-3-4
Pumped emergency core cooling system (ECCS) flow rate	Section 12-3-4

(1) Applicable to D. C. Cook Unit 1 and Unit 2 unless otherwise noted
(2) Applicable to D. C. Cook Unit 1 only
(3) Reflects safety injection water temperature range

References

1. WCAP-12945-P-A, Volume 1, Revision 2, and Volumes 2-5, Revision 1, "Code Qualification Document for Best Estimate LOCA Analysis," March 1998. (Proprietary)
2. WCAP-14449-P-A, Revision 1, "Application of Best Estimate Large Break LOCA Methodology to Westinghouse PWRs with Upper Plenum Injection," October 1999. (Proprietary)
3. WCAP-16009-P-A, Revision 0, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment of Uncertainty Method (ASTRUM)," January 2005. (Proprietary)
4. LTR-NRC-12-27, "Westinghouse Input Supporting Licensee Response to NRC 10 CFR 50.54(f) Letter Regarding Nuclear Fuel Thermal Conductivity Degradation (Proprietary/Non-Proprietary)," March 7, 2012.
5. Deleted
6. NEI 96-07 Revision 1, "Guidelines for 10 CFR 50.59 Implementation," November 2000.
7. AEP-NRC-2012-13, "Donald C. Cook Nuclear Plant Units 1 and 2, Response to Information Request Pursuant to 10 CFR 50.54(f) Related to the Estimated Effect on Peak Cladding Temperature Resulting from Thermal Conductivity Degradation in the Westinghouse-Furnished Realistic Emergency Core Cooling System Evaluation (TAC No. M99899)," March 19, 2012. (Available in NRC ADAMS database, accession number is ML12088A104)

ENCLOSURE 4 TO AEP-NRC-2012-38

Thermal Conductivity Degradation
Response to Request for Additional Information (RAI)

RAI 5

Documents referenced in this Enclosure will be provided upon request.

Thermal Conductivity Degradation
Response to Request for Additional Information (RAI)
RAI 5

RAI 5. Please explain how the changed design values will be verified during operation of the plant, i.e. TS limits, Surveillances, etc. Also, explain what compensatory actions will be taken if a value is found to be outside of the limits assumed in the analysis.

Response:

Enclosure 2 of Reference 1 presents tables of the eight design input values that were revised. Each of the changes resulted in more restrictive limits than assumed in the current Large Break Loss-of-Coolant-Accident (LBLOCA) design basis analyses-of-record (AORs). Each of the changed design values has corresponding administrative controls to verify proper values during operation, as discussed below.

The reduced maximum steam generator tube plugging (SGTP) limit is controlled via the unit-specific steam generator primary side surveillance procedures, which are a sub-set of the implementing procedures of the Steam Generator Program required by Technical Specification (TS) 5.5.7. Also, the SGTP Mechanical Design Standard (MDS) is being updated to reflect the revised limits. The SGTP MDS document provides the technical basis for plugging tubes in the Cook Nuclear Plant Steam Generators, and also identifies qualified tube plugs and the technical basis for the qualification of the Steam Generators following tube plugging. If the SGTP limits are exceeded a new analysis would be needed prior to entry into MODES 1, 2, 3, and 4 as required by TS 3.4.17, Steam Generator Tube Integrity.

The revised peaking factor limits presented as Tables 1 and 2 of Enclosure 2 of Reference 1 have been appropriately incorporated into the Core Operating Limit Report (COLR) for each unit. Additionally, the Engineering procedure controlling the process for Reactor Core Design is being updated to include the peaking factor burndown values to ensure compliance with the revised peaking factor limits in future core designs. Verification of the peaking factor limits is performed as part of the normal reload design process for each core reload. Steady state F_Q limits are verified by comparing predicted steady-state peaking factors at full power conditions against the steady-state burnup dependent F_Q peaking factor limits. Transient F_Q and $F_{\Delta H}$ limits are verified by comparing the predicted power distributions during normal operation and the operational transients against the applicable burnup dependent limits. Transient power distributions are generated based on the methodology described in Reference 2. Predicted power distribution used in reload analyses are based on core models developed using the NRC-approved ANC code described in Reference 3. Each reload cycle, these limits are analytically confirmed and verified. If the analytical verification produces unacceptable results, then the core is either redesigned or a LBOCA analysis re-assessment for TCD is performed with revised peaking factor input. The acceptability of analysis results is based on confirming that the reactor core is operating as designed.

Reactivity and power distribution measurements are performed periodically during the cycle as required by TS 3.1.2 (Core Reactivity), TS 3.2.1 (Heat Flux Hot Channel Factor ($F_Q(Z)$) and TS 3.2.2 (Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$) to verify that core reactivity and peaking factors are within their respective design limits. Measured power distributions and core reactivity are also compared against predicted power distributions and core reactivity. These comparisons when coupled with startup physics testing results following refueling are used to verify the core is operating as designed. This confirmation provides verification that the LBLOCA accident analysis input is within the specified limits. If the core is determined not to be operating as designed, an evaluation would be performed to assess analysis margins, understand the reasons for the deviation and make appropriate adjustments on a case-by-case basis to plant operations or setpoints to ensure operation remains within LBLOCA analysis limits.

The revised values for the Hot Full Power Nominal Vessel Average Temperature (T_{avg}) are consistent with the current operating values and the unit-specific operating procedures. A change in the reference T_{avg} value would require the plant configuration change process be followed. The Precautions, Limitations, and Setpoints document has been updated to include a discussion of the TCD evaluation and to cite the analysis limit on the T_{avg} value. Plant operating procedures provide controls for the operating temperatures of the units. If the temperature value was found to be outside of the limits the operators would take action to restore the value to be within the limit.

The revised values for the Accumulator Water Temperature (TACC) have considered that the accumulator tanks are within sub-compartments inside containment and have a more narrowly controlled temperature within these sub-compartments than the overall bulk lower containment temperature range specified by TS 3.6.5, Containment Air Temperature. The revised TACC range requirement is being administratively controlled by a newly created Technical Requirements for Operation (TRO) 8.6.6, Accumulator Temperature that has been added to each of the unit-specific Technical Requirements Manuals (TRMs). The TRO includes a surveillance to monitor the accumulator temperature every 24 hours. The TRO 8.6.6 structure includes Required Action statements to change Mode and reduce operating pressure in the event the accumulator area temperatures cannot be restored within the proper limits.

The revised Emergency Core Cooling System (ECCS) minimum flow rates correspond to the removal of excessive analytical conservatism from the supporting calculations. The flow rates continue to correspond to a calculated bounding minimum flow rate for a single train of Residual Heat Removal (RHR) and Safety Injection (SI). The sources of excess conservatism that have been removed include a) increased RWST level (from the centerline of the outlet pipe) to a more representative level for the LBLOCA analysis injection phase, and b) increased containment back-pressure assumption for the ECCS spilling flow calculations, thereby reducing the calculated spilling flow and increasing the flow delivered to the intact RCS loops. The revised minimum ECCS flow rates are supported by the surveillance testing of the ECCS per TS Surveillance Requirements 3.5.2.1 through 3.5.2.7. If the surveillance testing results of these TS SRs were not met, the appropriate Required Action of TS 3.5.2 would be followed.

The revised maximum ECCS injection temperature was updated to remove excessive analytical conservatism. The changed value is equal to the maximum Refueling Water Storage Tank

(RWST) temperature value, per TS SR 3.5.4.1. If the RWST temperature was found to exceed the TS limit, then the applicable Required Action statement of TS 3.5.4 would be followed.

The revised values for the delay for ECCS pumped injection to begin following the postulated LBLOCA represent the removal of excessive analytical conservatism for both the loss-of-offsite-power (LOOP), as well as the offsite-power-available scenarios. The revised response time values are supported by surveillance testing of the Engineered Safety Feature Actuation System (ESFAS) Instrumentation, per TS SR 3.3.2.12, and the emergency diesel generator start-up time surveillance testing, per TS SR 3.8.1.8.a. If the surveillance testing results of these TS SRs were not met, the appropriate Required Action of TS 3.3.2 and TS 3.8.1 would be followed.

For Unit 1 only, the LBLOCA TCD evaluation included a revised containment back-pressure boundary condition, which is further discussed in response to RAI question #3. The revised value still assures a conservatively low back-pressure is modeled, as required by the analysis methodology. This is an analytical value and is based upon conservative initial containment conditions controlled by TS, such as those within TS 3.6, Containment Systems, and the minimum RWST temperature controlled by TS Surveillance Requirement 3.5.4.1 that defines the minimum containment spray temperature. If a parameter were to be found to exceed its TS limit, then the applicable Required Action statement would be followed.

References

1. AEP-NRC-2012-13, "Donald C. Cook Nuclear Plant Units 1 and 2, Response to Information Request Pursuant to 10 CFR 50.54(f) Related to the Estimated Effect on Peak Cladding Temperature Resulting from Thermal Conductivity Degradation in the Westinghouse-Furnished Realistic Emergency Core Cooling System Evaluation (TAC No. M99899)," dated March 19, 2012.

2. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.

3. WCAP-10965-P-A, "ANC: A Westinghouse Advanced Nodal Computer Code," September 1986.