Duke Energy

M. S. Tuckman
*Executive Vice President*
*Nuclear Generation*

**Duke Energy Corporation**
526 South Church Street
P.O. Box 1006 (EC07H)
Charlotte, NC 28201-1006
*(704) 382-2200 OFFICE*
*(704) 382-4360 FAX*

April 7, 1999

U. S. Nuclear Regulatory Commission
Washington, D. C. 20555-0001

ATTENTION: Document Control Desk

Subject: Duke Energy Corporation

McGuire Nuclear Station Units 1 & 2
Docket Nos. 50-369, 50-370

Catawba Nuclear Station Units 1 & 2
Docket Nos. 50-413, 50-414

Response to NRC Requests for Additional Information on License Amendment Requests for McGuire and Catawba Nuclear Stations

By letters dated December 9, 1998 and January 5, 1999 the NRC requested additional information on Duke Energy Corporation's July 22, 1998 license amendment requests (LARs) for the McGuire Nuclear Station, Units 1 & 2; and the Catawba Nuclear Station, Units 1 & 2 Technical Specifications. These LARs would permit use of Westinghouse fuel at McGuire and Catawba. Topical Report DPC-NE-2009P/DPC-NE-2009 was also included in the July 22, 1998 Duke submittal.

By letter dated January 28, 1999, Duke Energy Corporation responded to the thirteen questions contained in the December 9, 1998 and January 5, 1999 NRC letters. However, the response to Question No. 11 was incomplete, pending Duke's receipt of additional information from Westinghouse Electric Company. Duke has now received this information from Westinghouse and hereby submits this to the NRC. This information is contained in a Westinghouse letter dated March 31, 1999 which is included as the attachment to this letter.

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Please address any comments or questions regarding this matter to J. S. Warren at (704) 382-4986.

Very truly yours,

M. S. Tuckman

M. S. Tuckman

Attachments

xc (w/Attachment):

Mr. L. A. Reyes, Regional Administrator
U. S. Nuclear Regulatory Commission - Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, GA 30303

Mr. F. Rinaldi, Senior Project Manager
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Mail Stop O-8 H12
Washington, DC 20555-0001

Mr. P. S. Tam, Senior Project Manager
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Mail Stop O-8 H12
Washington, DC 20555-0001

Mr. S. M. Shaeffer
NRC Senior Resident Inspector
McGuire Nuclear Station

Mr. D. J. Roberts
NRC Senior Resident Inspector
Catawba Nuclear Station

Westinghouse Electric Company

Box 355
Pittsburgh Pennsylvania 15230-0355

March 31, 1999

DPC-99-016

Mr. G. Swindlehurst, Section Manager
Safety Analysis, Nuclear Generation
Duke Power Company
P. O. Box 1006
Charlotte, NC 28201-1006

DUKE POWER COMPANY
SER Restriction Evaluations for SB and LB LOCA

Dear Mr. Swindlehurst:

In response to your request for assistance in responding to NRC Question 11 (included as Attachment 1), Westinghouse has prepared a response which addresses Westinghouse's compliance with restrictions imposed by NRC Safety Evaluation Reports (SERs) related to the Westinghouse 1985 SBLOCA Evaluation Model with NOTRUMP (References 1-4) and the 1981 Evaluation Model with BASH (References 5-13). Attachment 2 provides the NOTRUMP SER Restriction Compliance Summary. Attachment 3 contains the large break LOCA SER compliance information.

References:

1. WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code", N. Lee, et al., August 1985.
2. WCAP-1054-P-A, Addendum 2, Revision 1, "Addendum to the Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code: Safety Injection into the Broken Loop and COSI Condensation Model", C. M. Thompson, et al., July 1997.
3. WCAP-11145-P-A, "Westinghouse Small Break LOCA ECCS Evaluation Model Generic Study with the NOTRUMP Code", S. D. Rupprecht, et al., 1986.
4. WCAP-14710-P-A, "1-D Heat conduction Model for Annular Fuel Pellets", D. J. Shimeck, May 1988.
5. WCAP-10484-P-A, "Spacer Grid Heat Transfer Effects During Reflood", J. S. Chiou, et al., March 1991.
6. WCAP-10484-P-A, Addendum 1, "Spacer Grid Heat Transfer Effects During Reflood", D. J. Shimeck, December 1992.
7. WCAP-10266-P-A, Revision 2, "The 1981 Version of the Westinghouse ECCS Evaluation Model Using BASH", M. Y. Young, et al., March 1987.

8. WCAP-10266-P-A, Addendum 1, Revision 2, "The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code Addendum 1: Power Shape Sensitivity Studies", M. Y. Young, et al., January 1987.
9. NTD-NRC-95-4518, "Withdrawal of WCAP-12909-P on Power Shape Sensitivity Model (PSSM)", August 1995. [copy attached to DPC-95-224, "LOCA Axial Power Shape Sensitivity Model", K. B. Hanahan, August 1995.]
10. WCAP-9220-P-A, Revision 1, "Westinghouse ECCS Evaluation Model - 1981 Version", February 1982.
11. WCAP-8471-P-A, "The Westinghouse ECCS Evaluation Model: Supplementary Information", April 1975.
12. WCAP-8354-P-A, Supplement 1, "Long-Term Ice Condenser containment LOTIC Code Supplement 1", T. Hsieh, et al., July 1974.
13. ET-NRC-92-3746, "Extension of NUREG-0630 Fuel Rod Burst Strain and Assembly Blockage Models to High Fuel Rod Burst Temperatures", N. J. Liparulo, September 1992.

If you have any questions, please call Mr. John Besspiata at 412-374-4524 or me at 412-374-5651.

Sincerely,

Dwain W. Alexander
Customer Projects Manager

cc: J. J. Besspiata, W
S. P. Shaver, W Charlotte

bcc: J. M. Leonelli
D. W. Alexander
M. J. Boyles

**NRC Question 11, as received:**

11. The licensing analyses of reload cores with the RFA design will use the methodologies described in various topical reports and revisions for the analyses of fuel design, core reload design, physics, thermal-hydraulics, and transients and accidents, which were approved by NRC for analyses of current McGuire/Catawba cores not having the RFA design. For example, DPC-NE-1004A, PDC-NE-2011-PA, DPC-NF-2010A, and DPC-NE-3001-FA are used for the nuclear design calculations. DPC-NE-2004-PA, DPC-NE-2005-PA, and the VIPRE-01 code are used for the core thermal-hydraulic analyses and statistical core design. DPC-NE-3000-PA, DPC-NE-3001-PA, DPC-NE-3002A, and RETRAN-02 code are used for non-LOCA transient and accident analyses. Westinghouse small- and large-break LOCA evaluation models described in WCAP-10054-P-A and WCAP-10266-P-A, and related topical reports, are used for the small- and large-break LOCA analyses. Some of these methodologies have inherent limitations, and some have conditions or limitations imposed by the NRC SERs in their applications. Provide a list of the inherent limitations, conditions, or restrictions applicable to the RFA core design from all the methodologies to be used for the RFA reload design analyses, and describe the resolutions of these limitations, conditions and restrictions in the applications to the RFA cores and the transitional RFA/Mark-BW cores.

## NOTRUMP SER Restriction Compliance Summary

The following document contains a synopsis of the NRC imposed Safety Evaluation Report (SER) restrictions/requirements and the Westinghouse compliance status related to these issues. Not all the items identified are clearly SER restrictions, but sometimes state the NRC's interpretation of the Westinghouse Evaluation Methodology utilized for a particular aspect of the Small Break Loss Of Coolant (LOCA) Evaluation Model.

### WCAP-10054-P-A

WCAP-10054-P-A is titled "Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code," and is dated August, 1985. The following summarizes the SER restrictions and requirements associated with this WCAP:

**SER Wording (Page 6)**

"The use of a single momentum equation implies that the inertias of the separate phases can not be treated. The model therefore would not be appropriate for situations when separate inertial effects are significant. For the small break transients, these effects are not significant."

**SER Compliance**

Inherent compliance due to the use of a single momentum equation.

**SER Wording (Page 8)**

"To assure the validity of this application, the bubble diameter should be on the order of $10^{-1}$-2 cm. As long as steam generator tube uncovery (concurrent with a severe depressurization rate) does not occur, this option is acceptable "

**SER Compliance**

Westinghouse complies with this restriction for all Appendix-K licensing basis calculations. Typical Appendix-K calculations do not undergo a significant secondary side system depressurization in conjunction with steam generator tube uncovery due to the modeling methodology utilized.

**SER Wording (Page 14)**

"The two phase multiplier used is the Thom modification of the Martinelli-Nelson correlation. This model is acceptable per 10 CFR Part 50 Appendix K for LOCA analysis at pressure above 250 psia"

**SER Compliance**

The original NOTRUMP model was limited to no less than 250 psia since the model, as contained in the NOTRUMP code, did not contain information below this range. Westinghouse

extended the model to below 250 psia, as allowed by Appendix K paragraph I-C-2, and reported these modifications to the NRC via the 1995 annual reporting period (NSD-NRC-96-4639).

**SER Wording (Page 16)**

"Westinghouse, however, has stated that the separator models are not used in their SBLOCA analyses."

**SER Compliance**

Westinghouse does not model the separators in the secondary side of the steam generators for Appendix-K Small Break LOCA analyses; therefore, compliance exists.

**SER Wording (Pages 16-17)**

"Axial heat conduction is not modeled." and "Deletion of clad axial heat conduction maximizes the peak clad temperature."

**SER Compliance**

The Westinghouse Small Break LOCA is comprised of two computer codes, the NOTRUMP code which performs the detailed system wide thermal hydraulic calculations and the LOCTA code which performs the detailed fuel rod heatup calculations. The NOTRUMP code does not model axial conduction in the fuel rod and therefore complies. The LOCTA code has always accounted for axial conduction as is clearly stated in WCAP-14710-P-A which supplements the original NOTRUMP documentation.

**SER Wording (Page 17)**

"...; critical heat flux, W-2, W-3, or Macbeth, or GE transient CHF (the W-2 and W-3 correlations are used for licensing evaluations);..."

**SER Compliance**

The information presented here indicates that the NRC apparently misstated that Westinghouse was utilizing the W-2,W-3 correlations for Critical Heat Flux (CHF) in the fuel rod heat transfer model. A review of the analyses performed by Westinghouse, including those in WCAP-11145-P- A, indicates that the Macbeth CHF correlation has been utilized for all Appendix-K analyses performed by Westinghouse. This is consistent with the slab heat transfer map as described in WCAP-10054-P-A. In addition, the Macbeth correlation is specifically called out in Appendix K I-C-4-4 as an acceptable CHF model.

In a supplemental response to NRC questions (Specifically question 440.1 found in Appendix-A of WCAP-10054-P-A, Page A-10), a description of the core model describes the Macbeth as being utilized as the CHF correlation in the NOTRUMP Small Break LOCA model.

**SER Wording (Page 21)**

"The standard continuous contact model is not appropriate for vertical flow,..."

**SER Compliance**

The standard continuous contact flow links are not utilized when modeling vertical flow in the Appendix-K NOTRUMP Evaluation Model analyses; therefore, compliance is demonstrated.

**SER Wording (Page 27)**

"..., the hardwired choice of one fuel pin time step per coolant time step should result in sufficient accuracy."

**SER Compliance**

The NOTRUMP code continues to utilize only one fuel pin time step per coolant time step and therefore complies with this requirement.

**SER Wording (Page 47)**

"The code options available to the user but not applied in licensing evaluations were not reviewed."

**SER Compliance**

Westinghouse complies with this requirement.

**SER Wording (Page 53)**

"4. Steam Interaction with ECCS Water, a. Zero Steam Flow in the Intact Loops While Accumulators Discharge Water."

**SER Compliance**

Per paragraph I-D-4 Appendix-K, the following is stated:

> "During refill and reflood, the calculated steam flow in unbroken reactor coolant pipes shall be taken to be zero during the time that accumulators are discharging water into those pipes unless experimental evidence is available regarding the realistic thermal-hydraulic interaction between the steam and the liquid. In this case, the experimental data may be used to support an alternate assumption."

As can be seen, the specific Appendix-K wording can be considered applicable to Large Break LOCAs only since Small Break LOCAs do not undergo a true refill/reflood period. However, the Westinghouse Small Break LOCA Evaluation Model methodology is such that for break sizes in which the intact loop seal restriction is not removed (WCAP-11145-P-A Page 2-11), steam flow through the intact loop(s) is automatically (artificially) restricted via the loop seal model. While not specifically limited to zero, the flow is drastically reduced via the application of the artificial loop seal restriction model.

For breaks sizes above which the loop seal restriction is removed (typically >= 6 inch diameter breaks), this criterion is not explicitly adhered to. The implementation of the COSI condensation model into NOTRUMP (As approved by the NRC in WCAP-10054-P-A, Addendum 2, Revision 1), which is based on additional experimental documentation and improved modeling

techniques, more accurately models the interaction of steam with Emergency Core Cooling Water in the cold leg region. This experimental documentation supports the more accurate modeling of steam/water interaction in the cold leg region as allowed by Appendix-K. Note however that even with the COSI condensation model active, the accumulator injection condensation model still utilizes the conservative model as originally licensed in the NOTRUMP code.

**SER Wording (Page 7 of enclosure 2)**

"Per generic letter 83-35, compliance with Action Item II.K.3.31 may be submitted generically. We require that the generic submittal include validation that the limiting break location has not shifted away from the cold legs to the hot or pump suction legs."

**SER Compliance**

Westinghouse submitted WCAP-11145-P-A in support of generic letter 83-35 Action Item II.K.3.31. As part of this effort, verification was provided which documented that the cold leg break location remains limiting.

**WCAP-10054-P-A, Addendum 2, Revision 1**

WCAP-10054-P-A, Addendum 2, Revision 1 is titled "Addendum to the Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code: Safety Injection into the Broken Loop and COSI Condensation Model," and is dated July 1997. The following summarizes the SER restrictions and requirements associated with this WCAP:

**SER Wording (Page 3)**

"It is stated in Ref. 5 that the range of injection jet velocities used in the experiments brackets the corresponding rates in small break LOCAs for Westinghouse plants and that the model will be used within the experimental range. Also in References 1 and 5 Westinghouse submitted analyses demonstrating that the condensation efficiency is virtually independent of RCS pressure and state that the COSI model will be applied within the pressure range of 550 to 1200 psia."

**SER Compliance**

The coding implementation of the COSI model correlation in the NOTRUMP model restricts the application of the COSI condensation model to a default pressure range of 550 to 1200 psia and limits the injection flow rate to a default value of 40 lbm/sec-loop. The value of 40 lbm/sec-loop corresponds to the 30 ft./sec velocity utilized in the COSI experiments. As such, the default NOTRUMP implementation of the COSI condensation model complies with the applicable SER restrictions.

**WCAP-11145-P-A**

WCAP-11145-P-A, is titled "Westinghouse Small Break LOCA ECCS Evaluation Model Generic Study With The NOTRUMP Code," and is dated 1986. No specific SER restrictions were provided by the NRC as part of this WCAP review; however, the SER contains verification that the requirements of Item II.K.3.31 have been satisfied (i.e. break location study).

**SER Wording (Page 5)**

"We therefore, find that the requirements of NUREG-0737, Item II.K3.31, as clarified by Generic Letter 83-35, have been satisfied.

We find that a condition of the safety evaluation for NOTRUMP as applied to Item II.K.3.30 has been satisfied. The limiting cold leg break size for a 4-loop plant was reanalyzed at pump suction and at hot leg locations. The results confirmed that the cold leg break was limiting."

**WCAP-14710-P-A**

WCAP-14710-P-A, is titled "1-D Heat Conduction Model for Annular Fuel Pellets," and is dated May 1998. No specific SER restrictions are provided by the NRC in this document; however, a

conclusion was reached regarding the modeling of annular pellets during Small Break LOCA event.

**SER Wording**

"Based on its conclusions that the explicit modeling of annular pellets, as described in WCAP-14710(P), provides a more realistic representation in W Appendix K ECCS evaluation models of the annular pellets, while retaining conservatism in those evaluation models, the staff finds that the explicit modeling of annular pellets, as described in WCAP-14710(P), in W Appendix K LOCA evaluation models permits those models to continue to satisfy the regulations to which they were approved, and is, therefore, acceptable for incorporation into those models."

**SER Compliance**

Westinghouse performs sensitivity studies to assess the impact of modeling annular pellets on plant specific analyses.

## LARGE BREAK LOCA SER COMPLIANCE

Over the years a number of SERs have been issued with specified restrictions on model applications. The individual WCAP titles which have been published with an SER included that have conditions or limitations relevant to the BASH Evaluation Model have been reviewed in the context of the Catawba 2 Cycle 11 large break LOCA analysis. The relevant restrictions, limitations, and conditions specific to the BASH Evaluation Model as imposed by the NRC are listed, together with the means by which they are resolved in the Westinghouse Catawba Unit 2 Cycle 11 large break LOCA analysis.

### WCAP-10484-P-A

WCAP-10484-P-A is titled "Spacer Grid Heat Transfer Effects during Reflood" and is dated March, 1991. The following summarizes the SER restrictions and requirements associated with this WCAP:

SER Wording - "Acceptance of the droplet breakup model is premature due to the limited..information..." (page 16 of the WCAP-10484 SER)

SER Compliance - The droplet breakup model has been deleted from the LOCBART computer code and is not used in any BASH Evaluation Model (EM) analysis.

SER Wording - "The length average heat transfer coefficient h(Z/L) in the node should be used in applying the Y-H-L (Yao-Hochreiter-Leech) correlation." (page 16 of the WCAP-10484 SER)

SER Compliance - A review of the LOCBART computer code, Version 17.0 logic to compute grid single phase heat transfer enhancement identified the Y-H-L correlation value was not being averaged over the length of the node in some situations. This discovery led to the preparation of a Nonconformance Report concerning this error. LOCBART Version 18.0, which corrects the subject error, has been created and documented for use in the Catawba 2 Cycle 11 large break LOCA BASH EM analysis.

SER Wording - "The use of BART with grid rewet models should be restricted to the range of conditions consistent with the data base tested as indicated in Table 1 of this SER." (page 16 of the WCAP-10484 SER)

SER Compliance - WCAP-10484-P-A Addendum 1 supersedes the "BART with grid rewet" simulations presented here and is the reference for validation of these LOCBART models within the current BASH EM. The Catawba BASH EM analyses are "under the limitations delineated in (that) report," quoting the SER letter for the Addendum 1 WCAP.

**WCAP-10266-P-A, Revision 2**

WCAP-10266-P-A is titled "The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code " and is dated March, 1987. The following is a review of the SER restrictions and requirements found in this WCAP:

SER Wording - "The EM has no downward quench capability and therefore cannot be used for the analysis of either upper head injection plants or upper plenum injection plants." (page 10 of the WCAP-10266 SER)

SER Compliance - The BASH EM has not been applied in the large break LOCA analysis of any plant equipped with upper head injection or upper plenum injection. The upper head injection system has been removed from service at the Catawba Units.

SER Wording - "Westinghouse has committed to continue to analyze the large break LOCA with both minimum and maximum safety injection to confirm which produces the limiting large break scenario for each plant." (page 11 of the WCAP-10266 SER)

SER Compliance - The maximum SI scenario will be analyzed for the limiting discharge coefficient DECLG break as identified in the Catawba Unit 2 Cycle 11 BASH EM analysis.

SER Wording - "Westinghouse has committed to submit confirmatory analyses with the first BASH plant calculation of each type (2, 3 and 4 loop) to demonstrate that the cosine power shape is limiting and is the appropriate power shape to use for licensing calculations." (page 11 of the WCAP-10266 SER)

SER Compliance - This SER requirement was originally fulfilled for 3 and 4 loop plants via sensitivity studies presented in WCAP-10266-P-A, Addendum 1, Revision 2. However, the current BASH EM power shape methodology is to use an explicit approach introduced in 1995 for top-skewed power distributions, which was noticed to the NRC in NTD-NRC-95-4518. The disposition of this issue for the Catawba Units has been included in the PCT Margin Utilization Sheets, beginning with the 1995 10CFR50.46 Annual Reporting. The Catawba Unit 2 Cycle 11 BASH EM analysis will consider power shape effects consistent with the current methodology.

**WCAP-9220-P-A, Revision 1**

WCAP-9220-P-A, Revision 1 is titled "Westinghouse ECCS Evaluation Model - 1981 Version" and is dated February, 1982. This WCAP documents a number of changes to the existing large break LOCA EM which were implemented to correct errors and/or to obtain more favorable PCT results. Two separate Safety Evaluation Reports, dated August 29, 1978 and December 1, 1981 are included in the WCAP. The following is a review of the SER restrictions and requirements found in this WCAP which remain applicable to the BASH Evaluation Model. First, from the August 29, 1978 SER:

SER Wording - "Westinghouse has recently decided to cancel requests for using (Dougall-Rohsenow post-CHF heat transfer) correlation in place of the Westinghouse transition boiling correlation." (page xiv of WCAP-9220 Revision 1)

SER Compliance - The Westinghouse transition boiling correlation continues to be used in BASH EM calculations.

The restrictions and requirements identified in the December 1981 SER are discussed below:

SER Wording - "Based on the data and analyses contained in NUREG-0630....we find the (algorithm for computing heatup rates; rupture, strain, and blockage models; the prerupture strain model and the artificial limit on the degree of swelling), and their proposed applications to be acceptable." (page B-15 of WCAP-9220 Revision 1)

SER Compliance - The NUREG-0630 fuel rod burst and blockage models are programmed into the SATAN and LOCBART codes and are applied in BASH EM computations, including Catawba Unit 2 Cycle 11. Note that the SER restricted the usage of the NUREG-0630 model to calculated burst temperatures less than 950°C. In letter ET-NRC-92-3746 dated September 16, 1992 Westinghouse described the extension of the NUREG-0630 modeling to conservatively consider burst temperatures greater than 950°C.

**WCAP-8471-P-A**

WCAP-8471-P-A is titled "The Westinghouse ECCS Evaluation Model: Supplementary Information" and is dated April, 1975. The SER for this WCAP covers the entire set of WCAP reports that documented the Westinghouse model originally created and submitted when 10CFR50 and its Appendix K first became effective in 1974; it contains no restrictions and requirements as such other than for LOTIC as noted below.

SER Wording - "Until such time that LOTIC is modified to resolve the staff concerns.... a conservative minimum containment pressure of zero psig must be assumed in ECCS analyses of plants using an ice condenser containment." (page 3 of the WCAP-8471 SER)

SER Compliance - Approval of the LOTIC-2 computer code for ECCS minimum containment pressure analysis of ice condenser containments was obtained in the SER of WCAP-8354-P-A, Supplement 1. This code version has the capability of modeling additional ice condenser phenomena as required by the NRC. LOTIC-2 will be employed in the Catawba Unit 2 Cycle 11 BASH EM analysis.