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April 26, 2010  
LIC-10-0027

U.S. Nuclear Regulatory Commission  
Attn: Document Control Desk  
Washington, D.C. 20555

- References:
1. Docket 50-285
  2. EMF-2328(P)(A), Revision 0, "PWR Small Break LOCA Evaluation Model, S-RELAP5 Based," Framatome ANP, Inc., March 2001
  3. EMF-2103(P)(A), Revision 0, "Realistic Large Break LOCA Methodology for Pressurized Water Reactors," Framatome ANP, Inc., April 2003
  4. Letter from OPPD (R. P. Clemens) to NRC (Document Control Desk), "30-Day Report of a Significant Change/Error in the Loss of Coolant Accident (LOCA)/Emergency Core Cooling System (ECCS) Models Pursuant to 10 CFR 50.46," dated April 8, 2009 (LIC-09-0028)

**Subject: Annual Report for 2009 Loss of Coolant Accident (LOCA)/Emergency Core Cooling System (ECCS) Models Pursuant to 10 CFR 50.46**

In accordance with 10 CFR 50(46)(a)(3)(ii), the Omaha Public Power District (OPPD) submits the annual 10 CFR 50.46 summary report for 2009. This summary report updates all identified changes or errors in the LOCA/ECCS codes, methods, and applications used by AREVA (formerly Framatome ANP) to model Fort Calhoun Station (FCS), Unit No. 1. References 2 and 3 respectively describe the Small Break (SB) and Large Break (LB) LOCA analysis methodology used by AREVA for the FCS Analysis of Record.

OPPD has received the 2009 AREVA 10 CFR 50.46 Annual Notification Report for the SB and LB LOCA Analyses that are subject to the reporting requirements of 10 CFR 50.46.

The 2009 SB LOCA Analysis, Peak Clad Temperature (PCT), 10 CFR 50.46 Model Assessment errors are described in Attachment 1. Attachment 2 provides the 2009 SB LOCA Margin Summary Sheet for FCS. As a result of the  $-60^{\circ}\text{F}$  total errors for 2009 and the  $-8^{\circ}\text{F}$  total errors reported for 2008, the SB LOCA PCT changed from the baseline value (reported in the FCS Updated Safety Analysis Report) of  $1537^{\circ}\text{F}$  to  $1469^{\circ}\text{F}$ . The sum of the absolute values of the errors/changes in the SB LOCA analysis of record is  $76^{\circ}\text{F}$ . A 30-day report was submitted to the NRC (Reference 4) to document a greater than  $50^{\circ}\text{F}$  change in the peak cladding temperature.

The 2009 LB LOCA Analysis, PCT, 10 CFR 50.46 Model Assessment errors are described in Attachment 3. Attachment 4 provides the 2009 LB LOCA Margin Summary Sheet for FCS. As a result of the  $-49^{\circ}\text{F}$  total errors for 2009 and the  $-13^{\circ}\text{F}$  reported for 2008, the LB LOCA PCT changed from the baseline value (reported in the FCS Updated Safety Analysis Report) of  $1636^{\circ}\text{F}$  to  $1574^{\circ}\text{F}$ . The sum of the absolute value of the errors/changes in the LB LOCA analysis of record is  $76^{\circ}\text{F}$ . A 30-day report was submitted to the NRC (Reference 4) to document a greater than  $50^{\circ}\text{F}$  change in the peak cladding temperature.

In summary, the FCS PCT values for SB and LB LOCA remain less than the 10 CFR 50.46(b)(1) acceptance criteria of  $2200^{\circ}\text{F}$ .

If you should have any questions, please contact Mr. Bill Hansher at (402) 533-6894.

No commitments to the NRC are made in this letter.

Sincerely,



H. J. Faulhaber  
Division Manager  
Nuclear Engineering

Attachments:

1. 10 CFR 50.46 Small Break LOCA Model Assessments
2. Fort Calhoun Station Small Break LOCA Margin Summary Sheet
3. 10 CFR 50.46 Large Break LOCA Model Assessments
4. Fort Calhoun Station Large Break LOCA Margin Summary Sheet

## **10 CFR 50.46 Small Break LOCA Model Assessments**

### **S-RELAP5 Radiation to Fluid Correlation Under Predicts the Radiative Heat Transfer**

An issue was discovered during the development of a new radiation heat transfer model (for Revision 2 of the Realistic Large Break LOCA (RLBLOCA) methodology). A significant discrepancy between the currently used model in S-RELAP5 for the RLBLOCA methodology and other published models was discovered. A well known industry model was documented and installed into the TRAC-B code. Part of the documentation for that model is a figure which shows radiation heat transfer data versus the TRAC-B model and the Thomson model. This figure has also been copied and published in other journals and documents.

The radiation to fluid heat transfer model currently employed in S-RELAP5 for LOCA analyses used the flawed figure as the data basis for determining coefficients for the correlation of emissivity of water vapor. The result is that the S-RELAP5 radiation to fluid correlation under predicts the radiative heat transfer. This issue has been caused by flawed data used within the industrial community.

An evaluation has been performed to determine the impact on Peak Clad Temperature (PCT). For the Fort Calhoun SB LOCA analysis, the PCT impact was estimated to be -64°F.

### **Legacy Error in RELAP5 Series Heat Conduction Model**

Previously, the Idaho National Laboratory (INL) announced an error in the coding of the point kinetics model. The corrections were provided by the INL and then installed in S-RELAP5. Recently, the INL announced the previous error corrections were incorrect and the recommended convergence criteria supplied with those corrections should be retained.

The INL also announced that the heat conduction solution is incorrectly programmed. The error is associated with using the incorrect heat capacity when evaluating the right boundary mesh point. Instead of using the last (adjacent) mesh interval heat capacity, the code incorrectly used the next to last mesh interval heat capacity.

For the error associated with the point kinetics model, the estimated change in the SBLOCA PCT is +4°F, representing a retraction of the estimate related to the point kinetics model reported for 2008, but retaining the changes related to the convergence criteria. For the issue associated with the heat conduction model, the estimated PCT impact is 0°F. Thus, the overall effect on the SBLOCA PCT is +4°F.

### **Pellet Thermal Conductivity Degradation in RODEX Codes**

The RODEX2 and RODEX3 code series have been questioned as to their ability to account for burnup dependent thermal conductivity. It is considered that they may under-predict the fuel pellet temperatures at burnups near and beyond 20 GWd/MTU and therefore not be appropriate for initialization of LOCA evaluations. PWR SBLOCA analyses are insensitive to initial stored energy because sufficient excess cooling capacity exists during the blowdown phase of the transient to effectively remove any excess initial stored energy prior to the extended heatup period when PCT occurs. The estimated SBLOCA PCT impact is 0°F.

## Small Break LOCA Margin Summary Sheet – Annual Report

**Plant Name:** Fort Calhoun Station, Unit No. 1  
**Utility Name:** Omaha Public Power District

<b><i>Evaluation Model: Small Break LOCA</i></b>		
	<b>Net PCT Effect (<math>\Delta</math>PCT)</b>	<b>Absolute PCT Effect</b>
A. Prior 10 CFR 50.46 Changes or Error Corrections- Previous Years	-8°F	8°F
B. Prior 10 CFR 50.46 Changes or Error Corrections- This year	- 60°F	68°F
Absolute Sum of 10 CFR 50.46 Changes		76°F

The sum of the Peak Clad Temperature (PCT) from the most recent analysis using an acceptable evaluation model and the estimates of the PCT impact for changes and errors identified since this analysis is less than 2200°F.

## **10 CFR 50.46 Large Break LOCA Model Assessments**

### **S-RELAP5 Radiation to Fluid Correlation Under Predicts the Radiative Heat Transfer**

An issue was discovered during the development of a new radiation heat transfer model (for Revision 2 of the RLBLOCA methodology). A significant discrepancy between the currently used model in S-RELAP5 for the RLBLOCA methodology and other published models was discovered. A well known industry model was documented and installed into the TRAC-B code. Part of the documentation for that model is a figure which shows radiation heat transfer data versus the TRAC-B model and the Thomson model. This figure has also been copied and published in other journals and documents.

The radiation to fluid heat transfer model currently employed in S-RELAP5 for LOCA analyses used the flawed figure as the data basis for determining coefficients for the correlation of emissivity of water vapor. The result is that the S-RELAP5 radiation to fluid correlation under predicts the radiative heat transfer. This issue has been caused by flawed data used within the industrial community.

An evaluation has been performed to determine the impact on Peak Clad Temperature (PCT). For the Fort Calhoun LB LOCA analysis the PCT impact was estimated to be -27°F.

### **Legacy Error in RELAP5 Series Heat Conduction Model**

Previously, the INL announced an error in the coding of the point kinetics model. The corrections were provided by the INL and then installed in S-RELAP5. Recently, the INL announced the previous error corrections were incorrect and the recommended convergence criteria supplied with those corrections should be retained.

The INL also announced that the heat conduction solution is incorrectly programmed. The error is associated with using the incorrect heat capacity when evaluating the right boundary mesh point. Instead of using the last (adjacent) mesh interval heat capacity, the code incorrectly used the next to last mesh interval heat capacity.

The corrections for these two errors were installed into a new code version of S-RELAP5. Evaluations were performed for the Fort Calhoun LB LOCA analysis, and the effect on the PCT is -22°F.

### **Pellet Thermal Conductivity Degradation in RODEX Codes**

The RODEX2 and RODEX3 code series have been questioned as to their ability to account for burnup dependent thermal conductivity. It is considered that they may under-predict the fuel pellet temperatures at burnups near and beyond 20 GWd/MTU and therefore not be appropriate for initialization of LOCA evaluations. The Fort Calhoun limiting RLBLOCA case was sampled at 7 GWd/MTU and thus the RODEX3A code used in the analysis is over predicted at this burnup range, therefore the PCT impact is 0°F.

## Large Break LOCA Margin Summary Sheet – Annual Report

**Plant Name:** Fort Calhoun Station, Unit No. 1  
**Utility Name:** Omaha Public Power District

<b><i>Evaluation Model: Large Break LOCA</i></b>		
	<b>Net PCT Effect (<math>\Delta</math>PCT)</b>	<b>Absolute PCT Effect</b>
A. Prior 10 CFR 50.46 Changes or Error Corrections- Previous Years	-13°F	27°F
B. Prior 10 CFR 50.46 Changes or Error Corrections- This year	-49°F	49°F
Absolute Sum of 10CFR 50.46 Changes		76°F

The sum of the Peak Clad Temperature (PCT) from the most recent analysis using an acceptable evaluation model and the estimates of the PCT impact for changes and errors identified since this analysis is less than 2200°F.