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SUBJECT: Forwards summary of changes that have occurred through Dec 1997 & minor changes made in 1995,which were not reported as required,re ECCS evaluation model.

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February 2, 1998

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, 50-270, 50-287
Report Pursuant to 10 CFR 50.46, Changes to or Errors in an ECCS Evaluation Model

10 CFR 50.46 (a) (3) requires reporting at least annually changes or errors in ECCS evaluation models (EM) or in the application of such a model that affects the peak cladding temperature calculation. In preparing this letter, my staff discovered that minor changes made to the Oconee EM in 1995 were not reported as required. Accordingly, a summary of the changes that have occurred through December 1997 for the Oconee Nuclear Station is included in this letter. For the reporting period from January 1995 through December 1995, there were six changes made to the LOCA evaluation model and its application, including one significant code error that was reported to the NRC by B&W Nuclear Technologies (BWNT) under the 30-day notification requirement in May 1995. There were no changes made to the LOCA evaluation model during 1996. For the reporting period from January 1997 through December 1997, there were two changes made to the LOCA evaluation model and its application. It is also noted that NRC approved the Framatome Technology Incorporated (FTI)RELAP5-based LOCA EM (BAW-10192-P)on February 18, 1997. LOCA analyses for Oconee using this new EM are being phased in during this reporting period.

Questions should be directed to Lee Keller at (704) 382-5826.

Very truly yours,

M. S. Tuckman

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OCONEE NUCLEAR STATION
SUMMARY OF LOCA EM AND APPLICATIONS CHANGES OR ERRORS
DECEMBER 31, 1997

Core Flood Tank Initial Conditions and Core Inlet Enthalpy Inputs

Revised LOCA calculations were performed in support of B&W Owners Group Preliminary Safety Concern PSC 5-94. The first issue addressed by PSC 5-94 involves the initial core flood tank liquid inventory assumption. It was discovered that the use of a maximum initial liquid volume instead of a minimum liquid volume is conservative for the 2-ft elevation. For a maximum liquid volume, the initial gas volume is smaller and the reflooding rate is lower near the end of the adiabatic heatup when the 2-ft peak clad temperature occurs. At the 4-ft through 10-ft elevations, the minimum liquid volume remains conservative because the core flood tank empties earlier and the reflooding rates are lower later in the transient when the higher elevation peak clad temperatures occur. The second issue addressed by PSC 5-94 involves the use of non-conservative inlet enthalpy inputs in THETA1-B due to a non-homogeneous enthalpy calculation and the coarse data frequency used to transfer data from CRAFT2 to THETA1-B. Both of these issues only affect the LOCA analyses at the 2-ft elevation.

Fuel Pin Gap Conductance Model

Notification of an error in the THETA1-B fuel pin gap conductance model was made in May 1995 (Reference 9). Correction of this error would result in a reduction in the calculated unruptured-node PCT in excess of 50°F. The reduction in PCT would allow increases in the LOCA LHR limits at the upper core elevations. However, no increase in the core imbalance limits or operating limits would be obtained by correction of this error because the current fuel designs are LOCA limited by the 2-ft core elevation. This elevation is ruptured-node limited and thus is not subject to the gap error. The additional LOCA margin that may be available at the upper core elevations is unusable, and therefore the unruptured-node limited elevations that are subject to the code error are not reanalyzed.

Fuel Thermal Conductivity Decrease with Burnup

Recent fuel temperature calculations performed with the TACO3 code and using different fuel enrichment values have shown that higher enrichments produce slightly lower average fuel temperatures and lower fuel pin pressures at beginning of life. Conversely, at later times in life, higher enrichment values produce higher average fuel temperatures and higher internal pin pressures. As a result of these findings, the revised calculations performed at time-in-life conditions also incorporated conservative fuel temperature and pin pressure data consistent with higher fuel enrichments.

Fuel Rod Prepressure

For the Mark-B10F fuel rod (also called Mark-B10T fuel assembly), the initial linear heat rate (LHR) limit analyses were performed for a fuel rod prepressure of 245 psia. However, revised calculations were also performed to support a higher fuel rod prepressure of 370 psia. The increased pin prepressure significantly affects the removal of fuel stored energy during blowdown by causing clad plastic deformation to occur near mid-blowdown, rather than near the end of blowdown. The plastic deformation reduces the gap conductance and results in higher fuel temperatures at the end of blowdown. The linear heat rate is reduced at the upper elevations to reduce the initial fuel temperatures and offset the detrimental effects of the cladding plastic deformation.

Fuel Temperatures At Burnups Greater Than 40 GWd/mtU

A formal response to an NRC Request for Additional Information has identified that the LOCA initialization multiplicative value used with the TACO3 best-estimate fuel volume-averaged temperatures should be increased after 40 GWd/mtU. For burnups less than 40 GWd/MTU, the multiplicative value of 1.1151 is used to ensure that the predicted fuel temperature has a 95/95 tolerance range to cover code and manufacturing uncertainties. The multiplicative value increases linearly to 1.19 at a burnup of 65 GWd/mtU. This fuel temperature increase produces a detrimental effect on the LOCA peak clad temperatures. To ensure that the LOCA analyses remain bounding, all LOCA LHR limits above 40 GWd/MTU have been reduced by 0.075 kW/ft per GWd/mtU beyond 40 GWd/mtU. This penalty is applicable to all fuel designs for which TACO3 is used for calculating fuel temperatures at burnups greater than 40 GWd/mtU (Mark-B9, -B10, and -B11 fuel).

Steam Generator Tube Plugging

During a large break LOCA, steam generator tube plugging can cause greater steam binding during the blowdown portion of the transient, which redistributes the core flow during blowdown. Generally, the redistribution causes a decrease in the positive flow through the core, which reduces the initial fuel pin heat removal and produces higher end-of-blowdown temperatures. For small break LOCAs, a reduction in the core inventory due to tube plugging will result in a small increase in clad temperature for those break sizes that result in core uncovery. Framatome Technologies Incorporated (FTI) has developed and received NRC approval for the use of a RELAP5-based EM to replace the CRAFT2-based EM. The RELAP5 EM provides flexibility to address new fuel designs and represents improved calculational models and methods. The new RELAP5 EM is in the process of being applied to establish new licensing basis large and small break LOCA analyses for Oconee. Calculations with the RELAP5 EM account for steam generator tube plugging (unit average of 20% with a maximum steam generator tube plugging of 25%) for both large and small break LOCAs. This analyzed tube plugging level bounds the current maximum in any Oconee steam generator, which is less than 10%.

SBLOCA Emergency Feedwater Assumptions

Investigation of the CRAFT2 analysis sensitivity to emergency feedwater (EFW) boundary conditions revealed that the coarse modeling detail in the reactor vessel upper plenum region contributed to a beneficial holdup of liquid in the hot leg and steam generator tubes. This liquid holdup provided additional inventory for core boiloff and delayed the time of minimum inventory. RELAP5-based EM analyses with a detailed upper head model showed that the EFW flow variation could result in a slight level depression, but that this level decline would not produce a significant change in the calculated PCT. The CRAFT2 and RELAP5 sensitivity studies concluded that the high EFW flow used in the original CRAFT2 EM is non-conservative in terms of its effect on the core level for large to intermediate small break LOCAs. With lower EFW flows, both RELAP5 and CRAFT2 predict similar core mixture levels. For cases that predict core uncovery, the CRAFT2-based EM methods use FOAM2 and THETA1-B to predict the mixture level swell and PCT. Because these methods are extremely conservative, the predicted PCT was much higher for the CRAFT2 analyses. The increases in the PCT predictions are due to conservative flow rates used for the hot pin analyses, quiescent core mixture level swell based on average channel decay heat power, and excessively high radial peaking factors for the hot assembly. When the EFW flow was reduced, the CRAFT2 EM liquid holdup non-conservatism is negated, and the hot pin conservatisms take over to produce results that are extremely conservative for SBLOCA evaluations. Thus, the CRAFT2 EM produces more conservative results. The new RELAP5 EM analyses include feedwater assumptions which have been confirmed to be conservative, thereby resolving the EFW sensitivity issue.

Revised LOCA LHR Limits

The revised LOCA LHR limits calculated using CRAFT2 are provided in Tables 1 through 5 for all fuel types currently in use in Oconee reload cores. All of the applicable changes identified above have been implemented for all fuel types as appropriate. Linear interpolation is permitted between burnup steps for Tables 3, 4, and 5.

The revised LOCA LHR limits calculated using RELAP5 are provided in Tables 6 and 7 for the Mark-B9 and Mark B-10F fuel. All of the applicable changes identified above have been implemented for both fuel types as appropriate. These LHR limits will be phased in for reload designs beginning with Oconee 1 Cycle 18 and will replace the CRAFT2 EM limits in Tables 1 through 5.

References

1. FTI Document No. 51-1239250-00, "PSC 5-94 LOCA Reanalysis."
2. FTI Document No. 32-1234891-00, "Oconee-Specific LOCA LHR Limits for Mk-B9 Fuel."
3. FTI Document No. 32-1202149-04, "Mark-B9 LL Spectrum Study."
4. FTI Document No. 32-1232689-02, "Mk-B10 Rod LOCA Analyses."
5. FTI Document No. 32-1232689-03, "Mk-B10 Rod LOCA Analyses."
6. FTI Document No. 51-1234840-00, "Mk-B11 LTA LOCA Limits."
7. FTI Document No. 32-1239313-00, "LOCA Fuel Temperature Changes."

8. FTI Document No. 86-1266216-01, "Oconee R5/M2 MK-B9/B10F LOCA Summary."
9. Letter from J. H. Taylor (BWNT) to USNRC, "Report of a Significant Code Error in B&W's EM for B&W-Designed Plant per 10 CFR 50.46 Requirements," May 26, 1995.

Table 1
LOCA LHR Limits for Mark-B8 Fuel (kW/ft)

Elevation (ft)	<1,000 MWd/mtU	1,000-6,000 MWd/mtU	6,000-32,000 MWd/mtU	>32,000 MWd/mtU
2	14.8	14.8	15.5	See Note
4	16.1	16.6	16.6	See Note
6	16.1	16.1	16.1	See Note
8	17.0	17.0	17.0	See Note
10	16.0	16.0	16.0	See Note

Note: The linear heat generation rates (LHGRs) in the above table are valid independent of burnup only up to a burnup corresponding to 32,000 MWd/mtU. Beyond this burnup, the maximum rates are the lesser of the LHGR for 32,000 MWd/mtU or the LHGR given by the following linear function of burnup:

Maximum LHGR (kW/ft) = 25.314 - (2.2857×10^{-4})*(Burnup in MWd/mtU)

Table 2
LOCA LHR Limits for Mark-B9 Fuel (kW/ft)

Elevation (ft)	<2,700 MWd/mtU	2,700-10,650 MWd/mtU	10,650-40,000 MWd/mtU	>40,000 MWd/mtU
2	16.2	16.7	16.7	See Note
4	17.5	17.5	16.5	See Note
6	17.0	17.0	16.3	See Note
8	17.0	17.0	16.5	See Note
10	17.0	17.0	16.5	See Note

Note: The LHGRs in the above table are valid independent of burnup only up to a burnup corresponding to 40,000 MWd/mtU. Beyond this burnup, the maximum rates are the lesser of the LHGRs given by the following two linear functions of burnup (in MWd/mtU):

Max. LHGR (kW/ft) = 32.7 - (3.75×10^{-4})*(Burnup)
or = (LHGR for 40,000 MWd/mtU)-(7.5×10^{-5})*(Burnup-40,000)

Table 3
LOCA LHR Limits for Mark-B10F Fuel (kW/ft)
Prepressure ≤ 245 psia

Elevation (ft)	0 - 25,000 MWd/MTU	40,000 MWd/MTU	46,500 MWd/MTU	57,000 MWd/MTU
2	17.2	16.4	15.5	11.0
4	17.5	16.5	15.5	11.0
6	17.5	16.5	15.5	11.0
8	17.2	16.4	15.5	11.0
10	17.5	16.5	15.5	11.0

Table 4
LOCA LHR Limits for Mark-B10F Fuel (kW/ft)
Prepressure ≤ 370 psia

Elevation (ft)	0 - 25,000 MWd/mtU	40,000 MWd/mtU	46,500 MWd/mtU	57,000 MWd/mtU
2	17.2	16.4	15.5	11.0
4	17.0	16.3	15.5	11.0
6	17.0	16.3	15.5	11.0
8	16.5	16.2	15.5	11.0
10	17.0	16.3	15.5	11.0

Table 5
LOCA LHR Limits for Mark-B11 LTA Fuel (kW/ft)

Elevation (ft)	0 MWd/mtU	30,000 MWd/mtU	40,000 MWd/mtU	60,000 MWd/mtU
2.5	15.1	15.1	13.7	9.5
4.3	15.4	15.4	13.9	9.5
6.0	15.8	15.8	14.2	9.5
7.8	15.6	15.6	14.1	9.5
9.5	15.1	15.1	13.7	9.5

Table 6
LOCA LHR Limits for Mark-B10F Fuel (kW/ft)

Elevation (ft)	0 MWd/mtU	30,000 MWd/mtU	62,000 MWd/mtU
0.0	16.2	16.2	11.9
2.506	17.0	17.0	11.9
4.264	17.3	17.3	11.9
6.021	17.3	17.3	11.9
7.779	17.3	17.3	11.9
9.536	17.0	17.0	11.9
12.0	16.2	16.2	11.9

Note: All LHRs are valid for a pin prepressure of 245 psia with fuel enrichments between 3.0 and 5.0 wt%. Time-in-life LHRs are also valid for a pin prepressure of 370 psia with a fuel enrichment of 4.0 wt% or less. Linear interpolation for LHR limits is allowed between 30,000 MWd/mtU and 62,000 MWd/mtU.

Table 7
LOCA LHR Limits for Mark-B9 Fuel (kW/ft)

Elevation (ft)	28,000 MWd/mtU	45,000 MWd/mtU	62,000 MWd/mtU
0.0	15.8	15.8	13.36
2.506	16.6	16.6	13.36
4.264	17.0	17.0	13.36
6.021	17.0	17.0	13.36
7.779	17.0	17.0	13.36
9.536	16.6	16.6	13.36
12.0	15.8	15.8	13.36

Note: LHRs are valid for an initial fuel rod prepressure of 355 psia with a fuel enrichment of 4.0 wt% or less. Linear interpolation for LHR limits is allowed between 45,000 MWd/mtU and 62,000 MWd/mtU.