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ACCESSION NBR: 9712090075 DOC. DATE: 97/12/03 NOTARIZED: NO DOCKET #
FACIL: 50-261 H.B. Robinson Plant, Unit 2, Carolina Power & Light C 05000261
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SUBJECT: Transmits rept of non-significant changes & error
 corrections in acceptable LOCA evaluation models (EMs) & EM
 applications for ECCS at HB Robinson Steam Electric Plant.

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**Carolina Power & Light Company**

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Robinson File No: 13510

Serial: RNP-RA/97-0252

DEC 3 1997

U. S. Nuclear Regulatory Commission

Attn: Document Control Desk

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**H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/ LICENSE NO. DPR-23
REPORT OF NON-SIGNIFICANT CHANGES
AND ERROR CORRECTIONS IN ACCEPTABLE
LOSS-OF-COOLANT ACCIDENT EVALUATION MODELS
AND EVALUATION MODEL APPLICATIONS FOR THE
EMERGENCY CORE COOLING SYSTEM**

Gentlemen:

The purpose of this letter is to transmit the Carolina Power & Light (CP&L) Company report of non-significant changes and error corrections in acceptable Loss of Coolant Accident (LOCA) evaluation models (EMs) and EM applications for the Emergency Core Cooling System (ECCS) at the H. B. Robinson Steam Electric Plant (HBRSEP), Unit No. 2. The LOCA EMs are referenced in the Core Operating Limits Report (COLR), submitted to the NRC by letter dated September 30, 1997. Non-significant changes in EMs and EM applications were previously reported to the NRC by the fuel vendor, Siemens Power Corporation (SPC). The previous reports were provided to the NRC by Advanced Nuclear Fuels Corporation (ANFC) letters dated September 8, 1989, and October 4, 1990, and SPC letters dated October 18, 1991, January 11, 1993, February 14, 1994, March 10, 1995, May 29, 1996, September 5, 1996, and September 2, 1997. These reports describe non-significant changes and error corrections in the SPC EXEM Pressurized Water Reactor (PWR) Small Break LOCA (SBLOCA) EM for SBLOCAs and the EXEM PWR Large Break LOCA (LBLOCA) EM for LBLOCAs. The effects of the non-significant changes and error corrections on HBRSEP, Unit No. 2 Peak Clad Temperature (PCT) are summarized in Attachment I.

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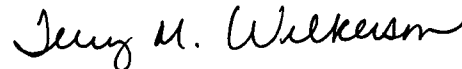


Prior to October 1993, the SBLOCA EM analysis was supplied by Westinghouse. An annual notification of changes and error corrections in the SBLOCA EM analysis was submitted to the NRC by CP&L letter dated July 24, 1992. Notification of a significant change to the Westinghouse SBLOCA EM was subsequently provided to the NRC by CP&L letter dated March 4, 1993. The effect of the change in SBLOCA EM associated with the change from the Westinghouse SBLOCA EM to the SPC SBLOCA EM was reported as a significant change by CP&L letter dated November 3, 1993.

By letter dated October 16, 1997, CP&L reported the latest PCT estimates for the LBLOCA, SBLOCA and transfer of the Emergency Core Cooling System (ECCS) to the recirculation Mode. The PCT effects of the non-significant changes and errors reported in Attachment I were introduced into the PCT estimates developed prior to the October 16, 1997, letter and are included in the latest PCT estimates repeated from the October 16, 1997, letter in Attachment II.

If you have any questions concerning this matter, please contact me or Mr. Harold Chernoff of my staff at (803) 857-1437.

Very truly yours,



T. M. Wilkerson
Manager - Regulatory Affairs

ALG/alg

- c: Mr. L. A. Reyes, Regional Administrator, USNRC, Region II
Mr. J. W. Shea, USNRC Project Manager, HBRSEP
Mr. B. B. Desai, USNRC Resident Inspector, HBRSEP

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
REPORT OF NON-SIGNIFICANT CHANGES
AND ERROR CORRECTIONS IN ACCEPTABLE
LOSS-OF-COOLANT ACCIDENT EVALUATION MODELS
AND EVALUATION MODEL APPLICATIONS FOR THE
EMERGENCY CORE COOLING SYSTEM

This report provides non-significant changes and error corrections in acceptable Loss of Coolant Accident (LOCA) evaluation models (EMs) and EM applications for the Emergency Core Cooling System (ECCS) at the H. B. Robinson Steam Electric Plant (HBRSEP), Unit No. 2. The LOCA EMs are referenced in the Core Operating Limits Report (COLR), submitted to the NRC by letter dated September 30, 1997. Non-significant changes in EMs and EM applications were previously reported to the NRC by the fuel vendor, Siemens Power Corporation (SPC). These reports describe non-significant changes and error corrections in the SPC EXEM Pressurized Water Reactor (PWR) Small Break LOCA (SBLOCA) EM for SBLOCAs and the EXEM PWR Large Break LOCA (LBLOCA) EM for LBLOCAs.

1. By letter dated September 8, 1989, Advanced Nuclear Fuels Corporation reported a minor model change in the EXEM PWR EM for the LBLOCA. The approved ICECON/CONTEMPT, PREFILL, SHAPE/REFLOOD, and REFLEX codes were combined into an integrated code, RFPAC. The maximum impact of this change on Peak Clad Temperature (PCT) was -19°F.
2. By letter dated October 18, 1991, SPC reported a change in the implementation to the approved Fuel Cell Test Facility (FCTF) heat transfer correlations. This change was later rejected by the NRC by letters to Siemens Power Corporation (SPC) and Carolina Power & Light (CP&L) Company dated October 11, 1996. The FCTF heat transfer correlations were later changed and new estimates of the effect of a significant error in the (LBLOCA) were provided by CP&L letters dated October 14, 1996, October 25, 1996, and January 17, 1997. Therefore, the change reported by SPC by letter dated October 18, 1991, is no longer in effect.
3. By letter dated January 11, 1993, SPC reported a minor correction to the EXEM PWR code that establishes the initial conditions for the transient in the fuel rod, RODEX2, correcting the formulation for the treatment of the pellet accommodation of swelling for values other than the default value. Since the RODEX2 analyses use the default value, no effect on PCT occurred as a result of the correction.

SPC also reported a minor error in the EXEM PWR code which calculates the hot rod heatup, TOODEE2, that related to the programming of the Dittus-Boelter correlation for the SBLOCA. The error involved using the film conditions to evaluate fluid properties instead of the bulk fluid conditions required by the correlation. The impact of this error was -2°F of PCT.

The Dittus-Boelter correlation was also programmed incorrectly in the ANF-RELAP Code used in the SBLOCA. Because the SBLOCA event involves primarily natural circulation flow rates in the Reactor Coolant System (RCS), the effect of the code error was judged by SPC to be insignificant and well within 50°F of PCT.

4. By letter dated February 14, 1994, SPC reported a minor error in the EXEM PWR code, TOODEE2, relating to incorrect coding of the ratio of the hydraulic diameter for the unblocked channel below the ruptured node to the hydraulic diameter of the channel with blockage above the ruptured node. The error had no effect on PCT.

An inconsistency was discovered in the z-equivalent model in TOODEE2. The z-equivalent model was coded with the axial shape for the FLECHT test rod instead of the FCTF test rod. The error correction had no impact on PCT.

5. By letter dated May 29, 1996, SPC reported a series of minor model changes and error corrections for the SBLOCA EM. The specific changes and effect on PCT follow.
 - a) The ANF-RELAP code, which calculates system response, TOODEE2 code, and RODEX2 code, were converted to a Hewlett-Packard (HP) workstation. The effect of this conversion on PCT for three applications of this EM including a maximum +5°F impact from the changes to the TOODEE2 code, was from +14°F to -22°F.
 - b) An ANF-RELAP code failure problem that required the user to restart the calculation with smaller time steps was corrected. The correction had no effect on PCT.
 - c) The transition from a horizontal to vertical flow regime in ANF-RELAP was increased from 15° to 30°. The change had no impact on PCT.
 - d) A typographical error in the input processor to the PIPE component of ANF-RELAP was corrected. The error correction had no impact on PCT.
 - e) A change was made to the TOODEE2 code to correct the error in the hydraulic diameter correction factor, reported by SPC letter dated February 14, 1994. The correction had no impact on PCT.
 - f) Consistent values for π , Rankine to Fahrenheit conversion, and Stephan-Boltzmann constant were incorporated into TOODEE2. This change had a 0.1°F impact on PCT.
 - g) Criteria was added to the TOODEE2 code to check if fuel melting occurs. This change had no impact on PCT.
 - h) Four minor changes to the TOODEE2 code were made to eliminate a 1 kpsi threshold for strain calculation, incorporate an update of the pre-rupture strain above the rupture node at the time of rupture, establish consistent temperature for both rupture and cladding strains, and compute the flow area for the node

below the rupture node consistent with the blockage model. This change had a 0.2°F impact on PCT.

- i) The TOODEE2 code was changed to use the ANF-RELAP average nodal qualities below mixture level for heat transfer correlations. This change had a 0.2°F impact on PCT for the SBLOCA.
- j) The TOODEE2 code was changed to use a weighted average heat transfer coefficient (liquid and steam) with the channel temperature at saturation. This change had a 0.1°F impact on PCT.
- k) The TOODEE2 channel temperature solution algorithm was changed. This change had no impact on PCT.
- l) The TOODEE2 code was changed to add a check on the cladding surface temperature to determine if the nucleate boiling heat transfer correlation is appropriate. This change had a 0.1°F impact on PCT.
- m) The TOODEE2 code was changed to add a warning if the power is input on a cladding node. This change had no impact on PCT.

The PCT impacts reported for TOODEE2 above were for the SBLOCA. The LBLOCA PCT impacts were within 0.1°F for any of the individual changes, and the combined impact was within 1°F.

The RODEX2 input processor was upgraded to allow ease of use and include some error checking. This change had no impact on PCT.

The RODEX2 code logic for treating the accommodation for the solid swelling by the as-fabricated porosity was corrected for higher density pellets. This change had no impact on PCT.

A series of minor model changes and error corrections were made to the LBLOCA EM. The specific changes and effect on PCT follow.

- a) The RELAP4 code, which computes the system and hot channel response and the RFPAC code, which computes containment temperatures, were transferred to the HP workstation. The impact of this change was not completed as of the SPC letter dated May 29, 1996, but SPC subsequently reported by letter dated September 5, 1996, that this change had no significant impact on PCT.
- b) An error in the original computer platform compiler was found during the transfer of RELAP4 to the HP workstation that affected the input. This change had an impact on PCT ranging from -8°F to +43°F.
- c) Two errors in the RFPAC code were discovered during the conversion of the code to the HP workstation. Two variables were not properly initialized and

another variable was misspelled. This change had less than a 1°F impact on PCT.

6. By letter dated September 2, 1997, SPC reported an error in the SBLOCA application of the ANF-RELAP code that determines the loop seal clearing behavior. By letter dated October 6, 1997, CP&L reported this error as a significant error. The impact on PCT was estimated to be 158°F.

The TOODEE2 code heat transfer correlation was modified such that a linear interpolation of reflood heat transfer coefficients is used between the effective reflood rates of 1.0 to 1.77 in/sec. By letters dated October 14, 1996, October 25, 1996, and January 17, 1997, CP&L reported this change as a significant error correction. The net impact on PCT as a result of the modified heat transfer correlation was an increase of 85°F to a PCT of 2114°F from a PCT of 2064°F previously calculated using the unmodified reflood heat transfer correlation. The estimated effect of the significant error also included a correction in the z-equivalent model that was previously reported by SPC letter dated February 14, 1994.

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
LATEST PEAK CLAD TEMPERATURE
ESTIMATES

The current Peak Clad Temperatures (PCTs) associated with Loss of Coolant Accidents (LOCAs) are listed below. The estimates include the cumulative effects of significant and non-significant error corrections and evaluation model changes to date.

<u>Event</u>	<u>PCT (°F)</u>
LBLOCA ECCS Injection Mode	2114
LBLOCA Transfer to Recirculation Mode	2102
SBLOCA ECCS Injection Mode	1978
SBLOCA Transfer to Recirculation Mode	No Heatup During Switch-over