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ESK-97-132

July 7, 1997

Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Document Control Desk

Subject: Quad Cities Nuclear Power Station Units 1 and 2
Plant Specific Emergency Core Cooling System (ECCS)
Evaluation Changes 10CFR50.46 Report
DPR-29 and DPR-30
NRC Docket Nos. 50-254 and 50-265

Reference: (a) "Quad Cities Nuclear Power Station Units 1 and 2 Plant Specific ECCS Evaluation Changes - 10CFR50.46 Report DPR-29 and DPR-30, NRC Docket Nos. 50-254 and 50-265," letter to USNRC from E. S. Kraft, Jr. (ComEd-QC), number ESK-96-063, dated April 24, 1996.

(b) Siemens Letter (R. A. Copeland) to USNRC (Document Control Desk), "ANF-91-048(P), Supplement 1 and ANF-91-048(NP), Supplement 1, "BWR Jet Pump Model Revision for RELAX", Siemens Power Corporation, May 1996.", RAC:96:042, dated May 6, 1996.

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This letter fulfills the thirty day reporting requirement of 10CFR50.46(a)(3) for Quad Cities Station Unit 2 because accumulation of the absolute magnitude of changes in the ECCS evaluation models or their application has resulted in a calculated Peak Clad Temperatures (PCT) difference of more than 50 °F. This letter also fulfills the annual reporting requirement of 10CFR50.46(a)(3) for Quad Cities Unit 1 and Unit 2.

Reference (a) is the most recent PCT change for Quad Cities. The attachments provide updated information regarding the PCTs for the Loss of Coolant Accident (LOCA) analyses of record. The assessment notes provide a detailed description for each change or error reported.

Attachment 1 Quad Cities Unit 1 10CFR50.46 Report (GE Fuel)
Attachment 2 Quad Cities Unit 2 10CFR50.46 Report (GE Fuel)
Attachment 3 Quad Cities Unit 2 10CFR50.46 Report (Siemens Fuel)
Attachment 4 Quad Cities Units 1 and 2 PCT Assessment Notes

Attachments 1-3 provide PCT information for the limiting LOCA evaluations, including all assessments as of June 8, 1997. The assessment notes in Attachment 4, provide a detailed description for each change and the error reported to us from our vendor.

Unit 1

The current General Electric (GE) LOCA analysis was approved in 1989 and utilizes approved methodology. It applies to all fuel operating in Unit 1 (currently all GE fuel), and the MAPLHGR limits calculated by GE will still apply to the GE fuel. The accumulation of the absolute magnitude of all previous changes described in Attachments 1 and 4 is less than 50°F for Unit 1. There have been no changes to the Unit 1 PCT assessments since the last 10CFR50.46 [Reference (a)].

Unit 2

This 10CFR50.46 report includes the PCT and all of the assessments for the co-resident GE fuel used for Quad Cities Unit 2 Cycle 15. There has been a change to the Unit 2 PCT assessments to be consistent with the Unit 1 assessment. The PCT for GE fuel changed from 1705°F to 1765°F as described in Attachment 2. The GE fuel PCT is calculated by GE and is the same analysis as described for Unit 1 above. This is also described in detail in Attachment 4.

In addition to the reporting of the PCT and assessments for GE fuel for Unit 2, Siemens Power Corporation (Siemens) LOCA analysis for ATRIUM™-9B fuel will be used for Unit 2 Cycle 15. The accumulation of the absolute magnitude of changes or errors in the ECCS evaluation models (or the application of new, approved models) has resulted in a calculated PCT difference of more than 50°F for Unit 2. The PCT increased from 1705°F for GE fuel to 1880°F for ATRIUM™-9B fuel as described in Attachment 3. The Quad Cities ATRIUM™-9B fuel LOCA analysis is being tracked and reported separately. This report is the initial 10CFR50.46 report for the introduction of ATRIUM™-9B fuel. A detailed description of the Siemens LOCA analysis is given in Attachment 4.

Unit 2 has Siemens fuel for Cycle 15 and will apply the Siemens LOCA re-analysis as the limiting PCT to bound both units. Unit 1 will load Siemens fuel for Cycle 16.

If you have any questions concerning this letter, please contact Mr. Charles Peterson, Regulatory Affairs Manager at (309) 654-2241, extension 3609.

Respectfully,

E. S. Kraft, Jr.
Site Vice President
Quad Cities Station

Attachment 1 Quad Cities 10CFR50.46 Unit 1 Report (GE Fuel)
Attachment 2 Quad Cities 10CFR50.46 Unit 2 Report (GE Fuel)
Attachment 3 Quad Cities 10CFR50.46 Unit 2 Report (Siemens Fuel)
Attachment 4 Quad Cities 10CFR50.46 - Assessment Notes

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# Attachment 1
# Quad Cities 10CFR 50.46, Unit 1 Report (GE Fuel)
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| | |
|---|---|
| PLANT NAME: | Quad Cities Unit 1 |
| ECCS EVALUATION MODEL: | SAFER/GESTR - LOCA |
| REPORT REVISION DATE: | 7/4/97 |
| CURRENT OPERATING CYCLE: | 15 |

**ANALYSIS OF RECORD**

Calculation: General Electric document NEDC-31345P, Revision 2, dated July, 1989
Fuel: P8x8R/BP8x8R which bounds GE8, GE9 and GE10
Limiting Single Failure: Battery Failure
Limiting Break Size and Location: 1.0 Double-Ended Guillotine Recirculation Suction Line Break

| | | |
|---|---|---|
| Reference PCT | PCT = | 1382°F |

**MARGIN ALLOCATION**

**A. PRIOR LOCA MODEL ASSESSMENTS***

| | | |
|---|---|---|
| LPCI injection delay to 75 seconds (Note 1) | Δ PCT = | +288°F |
| Extended Operating Domain & Equipment OOS (Note 2) | Δ PCT = | +10°F |
| Safety Evaluation Report for Core Spray Header Flaw (Note 3) | Δ PCT = | +110°F |
| Replacement Access hole cover modification (Note 4) | Δ PCT = | +10°F |
| CS injection valve stroke time increased to 50 seconds (Note 5) | Δ PCT = | +0°F |
| Bottom Head Drain Flowpath (Note 6) | Δ PCT = | +10°F |
| Remove NRC SER requirement for Core Spray Header Flaw (Note 7) | Δ PCT = | -110°F |
| CS Tee Box repair including CS piping leakage (Note 8) | Δ PCT = | +40°F |
| Jet Pump Riser repair penalty (Note 9) | Δ PCT = | +20°F |
| Shroud repair including access hole cover (Note 10) | Δ PCT = | +15°F |
| Remove penalty for Replacement Access hole cover (Note 11) | Δ PCT = | -10°F |
| Prior Assessments PCT | PCT = | 1765°F |

*Reported to USNRC on April 24, 1996

**B. CURRENT LOCA MODEL ASSESSMENTS**

| | | |
|---|---|---|
| Total PCT Change from Current Assessments | $\sum \Delta PCT$ = | 0°F |
| Cumulative PCT Change from Current Assessments | $\sum \lvert \Delta PCT \rvert$ = | 0°F |

**NET PCT** **PCT = 1765°F**

# Attachment 2
# Quad Cities 10CFR 50.46, Unit 2 Report (GE Fuel)
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| | |
|---|---|
| PLANT NAME: | Quad Cities Unit 2 |
| ECCS EVALUATION MODEL: | SAFER/GESTR - LOCA |
| REPORT REVISION DATE: | 7/4/97 |
| CURRENT OPERATING CYCLE: | 15 |

**ANALYSIS OF RECORD**

Calculation: General Electric document NEDC-31345P, Revision 2, dated July, 1989
Fuel: P8x8R/BP8x8R which bounds GE8, GE9 and GE10
Limiting Single Failure: Battery Failure
Limiting Break Size and Location: 1.0 Double-Ended Guillotine Recirculation Suction Line Break

| | | |
|---|---|---|
| Reference PCT | PCT = | 1382°F |

**MARGIN ALLOCATION**

**A. PRIOR LOCA MODEL ASSESSMENTS***

| | | |
|---|---|---|
| LPCI injection delay to 75 seconds (Note 1) | Δ PCT = | +288°F |
| Extended Operating Domain & Equipment OOS (Note 2) | Δ PCT = | +10°F |
| Replacement Access hole cover modification (Note 4) | Δ PCT = | +10°F |
| CS injection valve stroke time increased to 50 seconds (Note 5) | Δ PCT = | +0°F |
| Bottom Head Drain Flowpath (Note 6) | Δ PCT = | +10°F |
| Shroud repair including access hole cover (Note 10) | Δ PCT = | +15°F |
| Remove penalty for replacement access hole cover (Note 11) | Δ PCT = | -10°F |
| Prior Assessments PCT | PCT = | 1705°F |

*Reported to USNRC on April 24, 1996

**B. CURRENT LOCA MODEL ASSESSMENTS**

| | | |
|---|---|---|
| CS Tee Box repair including CS piping leakage (Note 8) | Δ PCT = | +40°F |
| Jet Pump Riser repair penalty (Note 9) | Δ PCT = | +20°F |
| Total PCT Change from Current Assessments | $\sum \Delta PCT$ = | +60°F |
| Cumulative PCT Change from Current Assessments | $\sum \lvert \Delta PCT \rvert$ = | 60°F |

| | | |
|---|---|---|
| **NET PCT** | **PCT =** | **1765°F** |

# Attachment 3
# Quad Cities 10CFR50.46, Unit 2 Report (Siemens Fuel)
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| | |
|---|---|
| PLANT NAME: | Quad Cities Unit 2 |
| ECCS EVALUATION MODEL: | EXEM BWR |
| REPORT REVISION DATE: | 7/4/97 |
| CURRENT OPERATING CYCLE: | 15 |

**ANALYSIS OF RECORD**

Evaluation Model: Advanced Nuclear Fuels Corporation Methodology for Boiling Water Reactors EXEM BWR Evaluation Model, ANF-91-048(P)(A), dated January, 1993 (Note 13).

Calculations:

1. "Quad Cities LOCA-ECCS Analysis MAPLHGR Limits for ATRIUM-9B Fuel," EMF-96-185(P), Revision 1, Siemens Power Corporation, dated March 1997.

2. "LOCA Break Spectrum Analysis for Quad Cities Units 1 and 2," EMF-96-184(P), Siemens Power Corporation, dated January 1997.

Fuel: ATRIUM™-9B
Limiting Single Failure: LPCI Injection Valve
Limiting Break Size and Location: 1.0 Double-Ended Guillotine in a Recirculation Suction Pipe

Reference PCT (see Note 13) PCT = 1880°F

**MARGIN ALLOCATION**

**A. PRIOR LOCA MODEL ASSESSMENTS**

None

**B. CURRENT LOCA MODEL ASSESSMENTS**

None

Total PCT Change from Current Assessments $\sum \Delta PCT$ = 0°F

Cumulative PCT Change from Current Assessments $\sum |\Delta PCT|$ = 0°F

**NET PCT** **PCT = 1880°F**

# Attachment 4
# Quad Cities 10CFR 50.46, Assessment Notes
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1. Delay in LPCI from 48 seconds to 75 seconds after LOCA initiation

On April 11, 1990, an Auto-Transfer Logic Operability Surveillance was completed during an outage on Unit 2. Part of this surveillance includes timing the transfer of Motor Control Center loads from Bus 29 to Bus 28 during a simulated Loss of Off-Site Power (LOOP) and failure of the Unit 2 Diesel Generator (DG). The transfer was timed at 38.99 seconds. The acceptance criteria for the time delay was 20 ± 5 seconds. ComEd had General Electric evaluate the consequences on a LOCA for this as-found relay setpoint drift. This evaluation assessed the impact of a time delay in LPCI injection due to power transfer during a LOCA and LOOP with a Battery Failure. General Electric determined that delaying the LPCI injection time to 75 seconds after the initiation of a LOCA resulted in a +288 degrees F PCT increase. General Electric practice has been to delay LPCI injection until the Recirculation Pump Discharge valve is completely closed. This valve is normally powered from Bus 29. LPCI injection time is therefore the Auto-Transfer Logic time plus the Recirculation Pump Discharge valve stroke time. The as-found relay setpoint drift would have resulted in a LPCI injection time of 63 seconds (39 seconds for the as-found transfer time and 24 seconds for the slowest Unit 2 Recirculation Discharge Valve). ComEd immediately restored the Auto-Transfer Logic to its design value of 20 seconds but conservatively retains a delayed LPCI as part of its LOCA analysis. This was described in a thirty day 10CFR50.46 report dated March 26, 1993. Quad Cities Units 1 and 2 currently maintain LPCI injection times at 75 seconds or less.

2. Extended Operating Domain/Equipment Out of Service (EOD/EOOS)

The report "Extended Operating Domain and Equipment Out of Service for Quad Cities Nuclear Power Station Units 1 and 2," GE Document NEDC-31449, Revision 1, April 1992 analyzed Quad Cities for an EOD allowing increased core flow above nominal values. Included as part of this analysis were the following EOOS and EOD operating modes: Feedwater Heaters Out-of-Service, Single Recirculation Loop Operation (SLO), Relief Valve Out-of-Service, Increased Core Flow (ICF), and Final Feedwater Temperature Reduction. The Extended Load Line Limit region and the ICF region of the power/flow map were supported for all fuel types used. Table 1 below summarizes the combined modes of operation analyzed in the EOD and EOOS document for Quad Cities. Note that with the exception of the SLO condition, the EOOS analyses are valid for the Increased Core Flow Region. The conclusions of the EOD/EOOS report for Quad Cities assessed the impact on LOCA Peak Clad Temperature (PCT) as less than +10 °F.

Table 1
Equipment Out of Service Analysis and Extended Operating Domain
for Quad Cities Units 1 and 2

| EQUIPMENT OUT OF SERVICE | APPLICABLE OPERATING DOMAIN |
|---|---|
| Relief Valve-OOS | EOD Including ICF Region |
| Feed Water Heater-OOS | EOD Including ICF Region |
| Feed Water Heater -OOS and Relief Valve -OOS | EOD Including ICF Region |
| Single Recirculation Loop Operation | EOD Excluding ICF Region |
| Single Recirculation Loop Operation and Relief Valve -OOS | EOD Excluding ICF Region |

3. Reactor Vessel leakage assessed for Unit 1 Cycle 14

Emergent leakage paths associated with core shroud flaws, core spray piping flaws (repaired on Unit 1 Cycle 15) and jet pump riser flaws (repaired Unit 1 Cycle 14) were evaluated and assigned PCT increases. For Quad Cities Unit 1 emergent leakage paths described above resulted in an increase in PCT of 110 °F as accepted in the NRC SER letter from Chandu P. Patel dated August 4, 1994. This increase resulted in a limiting PCT of 1790 °F for Unit 1 only. As a result of subsequent repairs to the Unit 1 Shroud and Core Spray line, the increase in PCT of 110 °F from the NRC SER was removed and replaced with separate PCT assessments associated with each repair. (Note: 110 °F PCT increase was imposed on Unit 1 for fuel cycle 14 only.)

4. Replacement access hole cover

This PCT increase was applied to Quad Cities with the modification of the access covers in the core shroud support plate. These removable covers allow access from the downcomer region to the lower plenum region. This modification changed the design of the access cover from a welded design to a bolted design. The small amount of leakage associated with the bolted joint was analyzed and resulted in less than a 10 °F PCT increase. Note that leakage from these access covers was included in each of the subsequent LOCA evaluations. (See note 12 for a summary of leakage which has impact on LOCA/ECCS analysis.)

5. CS Injection valve maximum stroke time increased from 15 to 50 seconds

Modification of the CS injection valve stroke time was necessary as a part of NRC Generic Letter 89-10 compliance. The supporting LOCA evaluation addressed the impact of increasing the Core Spray (CS) injection valve stroke time from a maximum of 15 seconds to a maximum of 50 seconds. This analysis credits the partial Core Spray flow while valves are stroking open which compensated for the longer injection valve stroke times. GE completed the analysis using their licensed SAFER/GESTR methods and determined there was no change to the LOCA PCT.

6. Bottom Head Drain flowpath

GE reported under 10CFR50.46 on December 15, 1995, that the impact of the Reactor Pressure Vessel (RPV) Bottom Head Drain (BHD) providing an additional flow path for coolant loss under LOCA conditions was an increase of less than 10 °F on the PCT. Continuous Reactor Water Cleanup system operation takes suction from the BHD and from the Recirculation suction piping which are connected at a common point. A design basis LOCA where the break is on the Recirculation suction piping would allow water in the lower plenum of the reactor vessel to be lost through the Reactor Water Cleanup piping where it connects to the Recirculation suction piping. (See note 12 for a summary of leakage which has impact on LOCA/ECCS analysis.)

7. Remove increase in PCT of 110 °F (from NRC SER requirement, see note 3)

As a result of the repairs to Unit 1 shroud and Core Spray Line, the increase in PCT of 110 °F required by the NRC SER in note 3 was removed and replaced with PCT assessments associated with each repair.

8. Core Spray (CS) Tee Box repair including CS piping leakage

The purpose of the assessment was to analyze the impact of installing the CS Tee Box repair clamp. This modification was necessary as a result of cracks found in the Unit 1 Tee Box and subsequent repair. This assessment is also being applied to Unit 2 to account for calculated leakage in the Unit 2 Core Spray piping. This PCT assessment was done for 4,100 GPM of CS delivered to the top of the core. The previous LOCA analysis was performed with 4500 GPM of CS delivered to the top of the core. The maximum CS leakage was calculated to be less than 400 GPM with the Unit 1 CS Tee box repair which included the flaw and the design leakage from the thermal sleeve / safe end interface. The leakage calculated for Unit 1 conservatively bounds the leakage calculated for Unit 2. This 400 GPM of leakage used in the LOCA analysis when subtracted from the Tech Spec required 4500 GPM conservatively assumes leakage in excess of the maximum calculated leakage for Unit 1. This 400 GPM reduction in CS flow results in the 40 °F PCT penalty. This excess leakage can be used for assessment of consequences for any additional CS line flaws that may occur in the future. Note that as a result of the subsequent repairs to Unit 1 CS, the increase in PCT of 110 °F was later removed and replaced with separate PCT assessments associated with each repair. This increase in PCT of 40 °F is associated with the CS leakage including the Tee Box repair. (See note 12 for a summary of leakage which has impact on LOCA/ECCS analysis.)

9. Jet Pump Riser repair

Potential leakage paths associated with jet pump riser cracks (repaired with the startup of Unit 1 Cycle 14) were evaluated and assigned PCT increases. GE evaluated the PCT increase for two leakage scenarios which were evaluated and submitted to the NRC on July 14, 1994. In that letter, the nominal leakage scenario (including the Core Spray flaw along with the repaired jet pump riser) resulted in an increase in PCT of 20 °F. Note that as a result of the subsequent repairs to Unit 1 shroud and Core Spray, the increase in PCT of 110 °F from the NRC SER was later removed and replaced with separate PCT assessments associated with each repair. This increase in PCT of 20 °F is associated with the nominal leakage from the jet pump riser repair. Although Unit 2 was not found to have any jet pump riser cracks with leakage, this leakage penalty is also being conservatively applied to Unit 2 for consistency between the Units. (See note 12 for a summary of leakage which has impact on LOCA/ECCS analysis.)

10. Shroud repair including access hole cover

Repairs to the Quad Cities core shroud were completed with the startup of Unit 1 Cycle 15 and with the startup of Unit 2 Cycle 14. These repairs included installation of hardware which required machining of holes in the shroud and shroud support plate. Each of these holes has some clearance which will allow some leakage to occur at the hole's location. Also, the leakage of the cracks found in the shroud were included in the repair PCT assessment. This repair on each Unit resulted in an increase of 15 °F when compared to the LOCA analysis without any shroud leakage. Included in the assessment was the replacement access hole cover leakage. Note that as a result of the repairs to Unit 1 shroud, the increase in PCT of 110 °F from the NRC SER was removed and replaced with separate PCT assessments associated with each repair. This increase in PCT of 15 °F is associated with the leakage from the shroud repair. (See note 12 for a summary of leakage which has impact on LOCA/ECCS analysis.)

11. Remove replacement access hole cover penalty

As a result of the shroud repair assessment which included access hole cover leakage, the increase in PCT of 10°F from the modification specific assessment was removed and replaced with PCT assessment associated with shroud repair.

12. ECCS leakage

Leakage values which reduce the effectiveness of the ECCS have been calculated for both Quad Cities Unit 1 and 2. The following table addresses the source of the leakage, the amount of leakage, and how the calculated leakage is conservatively analyzed.

**Quad Cities Units 1 & 2 ECCS Leakage Currently Analyzed**

| Leakage Source | Current Unit 1 Calculated Leakage (GPM) | Current Unit 2 Calculated Leakage (GPM) | Currently Analyzed Leakage (GPM) |
|---|---|---|---|
| 20 Jet Pump Slip Joints | 225 | 225 | 225 |
| 10 Jet Pump Bolted Joints (LPCI Only) | 582 | 582 | 582 |
| 2 Access Hole Covers less 1 bolt | 146 | 146 | 146 |
| Core Shroud Weld Cracks | 150 | 150 | 150 |
| Core Shroud Weld Repair Holes | 350 | 350 | 350 |
| Bottom Head Drain Line | 480 | 480 | 480 |
| Jet Pump Riser Crack, per loop (LPCI only)* | 180 | 0 | 180 |
| Core Spray Piping Flaw*** near rated system flow per loop | 62 | 31 | ** |
| RPV assembly penetration Thermal Sleeve / Safe End Interface | 103 | 103 | 400 |
| Vent Holes In Core Spray Line T-box | 8 | 8 | ** |
| Core Spray Line T-box Flaws w/Repair | 144 | 0 | ** |

* See Assessment Note 9

** The 400 GPM of RPV assembly penetration leakage listed in the table is equivalent to 400 GPM of total leakage for the RPV assembly leakage, Upper T-box vent hole leakage, and the Core Spray (CS) line postulated crack leakage. Since all of these leakages occur in the CS line between its entry into the vessel and the penetration of the core shroud, the distribution of these leakages is insignificant. Conservatively, none of the CS leakage flow is credited to enter the vessel.

*** The end-of-cycle crack lengths (including unit specific projected crack growth) were used to calculate the leakages used for this analysis. ComEd's projected crack growth period used in the LOCA analysis for a given flaw is consistent with the schedule for re-inspection of that flaw. This ensures that appropriate leakage is used in the LOCA PCT evaluation. ComEd will use end of life leakage flows for flaws which can not be verified by re-inspection.

13. Introduction of Siemens ATRIUM-9B fuel to Quad Cities Station

Beginning with Quad Cities Unit 2 Cycle 15, Siemens ATRIUM-9B fuel will be co-resident in the core with General Electric fuel. ComEd tracks the LOCA/ECCS evaluation models of these fuels separately through the respective vendors approved LOCA/ECCS evaluation methodologies. ComEd has ensured that there is consistency between the analyzed licensing basis configuration and assumptions for the two respective LOCA/ECCS analyses of record. In certain cases, differences exist based on methodology. These differences were initiated to assure conservative 10CFR50.46 results within that vendor's methodology. As a result of using Siemens methodology, Siemens calculated a different limiting single failure than the previous GE analysis. The change in the limiting single failure is a result of applying the Siemens methodology and it is not due to the use of the Siemens ATRIUM™-9B fuel. Siemens has demonstrated the hydraulic compatibility of the ATRIUM™-9B and GE fuel and concluded that the mixed core effects have a negligible impact on the PCT calculation. Therefore, the GE PCT calculation for the GE fuel remains applicable, and the Siemens PCT calculation is appropriate for the ATRIUM™-9B fuel.

The currently used methodology by Siemens Power Corporation (EXEM BWR [ANF-91-048(P)(A)]) requires the use of a conservative, constant ECCS injection temperature. Siemens has determined that an elevated value yields the most conservative PCT results. The value used for the Quad Cities Siemens LOCA analysis was 170 °F and 120 °F was used for the GE SAFER/GESTR-LOCA analysis. The value Siemens used conservatively bounds the maximum suppression pool temperatures for the initial period of the LOCA during which the PCT is reached and then mitigated. This temperature was derived from the suppression pool analysis as shown in the UFSAR.

Siemens Power Corporation methodology also utilizes a reflood criteria liquid entrainment flow rate which allows the switch from hot channel steam cooling Appendix K heat transfer coefficient to the Appendix K spray cooling heat transfer coefficient. The Siemens FLEX computer code is used to determine the core and system response during the reflood and refill phases of a LOCA. A sustained non-zero value for relative entrainment is the criteria that FLEX uses to determine the time of core reflood. In this analysis, Siemens has applied a conservative supplemental reflood criteria of absolute entrained liquid flow rate at the plane of interest to determine the time of core reflood. Siemens determined that a revised absolute entrained liquid flow rate is appropriate for the ATRIUM™-9B fuel. Siemens' reflood criteria flow rate was empirically demonstrated to effectively quench a cladding temperature excursion with a full sized ATRIUM-9B bundle test apparatus. Siemens presented the revised supplemental criteria to the NRC on January 9, 1997 and provided an information letter on January 21, 1997 to document the supplemental criteria.

In February of 1997, Siemens reported an error on the application of the HUXY code. The HUXY code is used to perform heatup calculations for the entire LOCA transient and yields PCT and local oxidation at the axial plane of interest. HUXY uses the time dependent pressure difference across the fuel cladding to determine the amount of strain experienced by the cladding and the resulting potential for rod ballooning and rod failure. The internal rod pressure is calculated by HUXY while the time dependent system pressure is obtained from the blowdown and refill/reflood calculations. The approach of using a constant system pressure of 14.7 psia was mistakenly thought to be conservative since the occurrence of fuel failures during an accident increases PCT and Metal Water Reaction rate. However, it was discovered that using a larger cladding pressure difference is not always conservative. Siemens performed the Attachment 3 Quad Cities limiting LOCA/ECCS analyses properly applying the time dependent pressure calculated during blowdown and refill/reflood to the HUXY heat up calculation. Siemens identified and removed the error from the Quad Cities limiting case and addressed the HUXY system pressure error PCT impact on the non-limiting break spectrum analysis. The error resulted in a maximum of +32°F above the calculated PCTs for certain small break size cases. Siemens re-analyzed certain non-limiting cases with the error removed to confirm that the break spectrum analysis had correctly identified the most limiting break size, location and single failure.